Bieberz, N.W

OPERATING INSTRUCTIONS

TYPE 1136-A

DIGITAL-TO-ANALOG CONVERTER

1136-A

1136-A

GENERAL RADIO COMPANY

OPERATING INSTRUCTIONS

TYPE 1136-A

DIGITAL-TO-ANALOG CONVERTER

Form 1136-0100-A
November, 1963

Copyright 1963 by General Radio Company
West Concord, Massachusetts, USA

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS, USA

Figure 1-1. Panel view of the Type 1136-A Digital-to-Analog Converter.

SPECIFICATIONS

Data Input: BCD weighted 1-2-4-2 or 1-2-2-4. Minor modification adapts for 1-2-4-8 input. Binary 1 at least 6 volts positive with respect to binary 0. Input impedance 50 kilohms. Binary 0 can be offset from ground by ±150 volts. Switch selects any adjacent three or the last two digits of up to nine-decade input.

Conversion Rate: Up to 10,000 conversions per second (controlled by digital measuring instrument).

Over-all Accuracy: ±0.1% of full scale (includes repeatability, long-term stability, linearity, ±10% line variation, and +15 C ambient-temperature variations around normal 25 C) ± 0.0001% x conversion rate in cps.

Storage Transfer: 50-μsec transfer time.

Storage Command Pulse: 5 μsec, ±6 volts minimum into 10 kilohms, rise and fall times less than 1 μsec.

Output: 1 milliampere with 15-kilohm source impedance, or 100 millivolts with 100-ohm source impedance. Negative side grounded if binary 0 or input not more than 20 volts from ground. Output floating if offset voltage larger than 20 volts.

Load: 2000 ohms maximum for 1 milliampere output. 1000 ohms minimum for 100 millivolts output.

Linearity: ±0.05% of full scale.

Stability: ±0.02% for ±10% line voltage; ±0.003% of full scale per degree C.

Accessories Supplied: TYPE CAP-22 Power Cord, spare fuses.

Accessory Available: TYPE 1136-P1 Cable with diode-matrix, required for use with 10-line decimal data from General Radio counters of the 1150 series.

Power Requirements: 105 to 125 (or 210 to 250) volts, 50 to 400 cps, 7 watts.

Cabinet: Rack-bench.

Dimensions: Bench model — width 19, height 3½, depth 12 inches (485 by 89 by 305 mm), over-all; rack model — panel 19 by 3½ inches (485 by 89 mm), depth behind panel 11 inches (280 mm).

Net Weight: 13 pounds (6 kg). **Shipping Weight:** 17 pounds (8 kg).

General Radio Experimenter references: Vol 37, No. 12, Dec. 1963.

SECTION 1

INTRODUCTION

1.1 PURPOSE.

The Type 1136-A Digital-to-Analog Converter (Figure 1-1) converts digital input data comprising three decades of four-line, binary coded-decimal data into an output current or voltage with 0.1% increments. The output can be displayed on the screen of an oscilloscope or recorded by galvanometer- or potentiometer-type recorders.

Self-contained data storage, high conversion rate, and stability combined with flexibility of input requirements make the Type 1136-A universally applicable.

1.2 DESCRIPTION.

1.2.1 GENERAL. The converter accepts a three digit, four-line, binary-coded decimal input signal with 1-2-2-4 or 1-2-4-2 weighting. With a minor modification, 1-2-4-8 weighting can be accepted. Figure 1-2 is an elementary circuit diagram of one decade. The binary input of each line is applied to an amplifier (A1, A2, A3, or A4). The amplifiers' outputs operate, through inhibit gates (G1 through G4), the output switches (S1 through S4). The inhibit gates are opened only when a storage-command pulse is applied. During the interval when the gates are open, the input data are fed to the self-latching switches (S1 through S4). These switches are then set to correspond to the binary input. After the inhibit gates are closed, the output switches remain in the same state until the input data change. If the input data remain the same, the output switches are not affected when the inhibit gates are reopened. This system provides "jammed" transfer and the output switches are not reset to "zero" before new data are transferred.

The output switches (standardizers) connect the weighting resistors (R1 through R4) either to 0 volt (binary 0) or to +E volts (binary 1). The 1-ma output is essentially a 15-volt swing behind 15 kilohms. For 100-mv output a 100-ohm resistor is connected across the output terminals.

1.2.2 CONTROLS. Table 1 lists the controls on the Type 1136-A:

TABLE 1
CONTROLS

NAME	TYPE	FUNCTION
POWER	Toggle switch	Turns power on and off.
NUMERAL POSITION	9-position rotary switch	Selects any adjacent 3, or the last 2, digits of a 9-decade input.
SET FULL SCALE COARSE/FINE	Concentric potentiometer and rotary switch	Output adjustment.
OUTPUT 1 ma/100 mv	Toggle switch	Output selector: 1 ma for galvanometer, or 100 mv for potentiometer recorder.

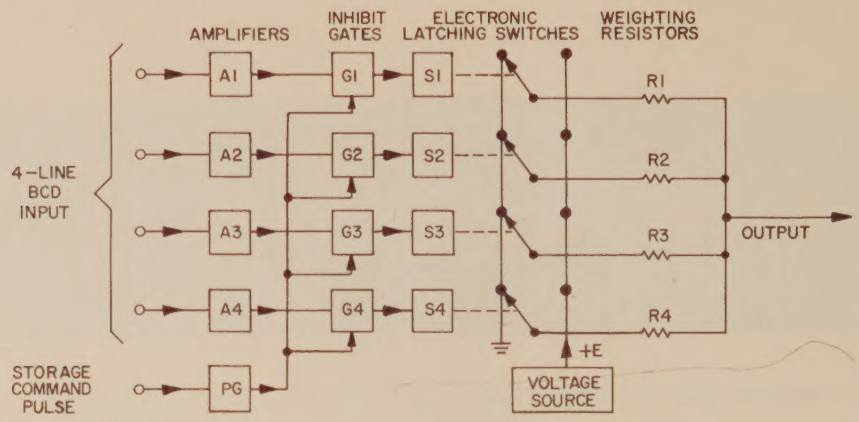


Figure 1-2. Elementary circuit diagram of one decade of the Type 1136-A.

SECTION 2

PRINCIPLES OF OPERATION

2.1 GENERAL.

Figure 2-1 is a simplified schematic diagram of the Type 1136-A Digital-to-Analog Converter. The input is BCD weighted 1-2-4-2 with a binary-0 input of 0 volt and a binary-1 input of +6 volts. The recorder is assumed to have zero impedance. The input data have been transferred into storage, i.e., the output switches have assumed states which correspond to the input data. Each switch connects its weighting resistor to 0 volt for binary-0 state or to +E (+15 v) for binary 1. Table 2 lists the currents contributed to the output when the switches are in the "1" state.

The sum of all branch currents is 999 μa. If the recorder impedance is not negligible compared with the 15-kilohm source impedance, the voltage +E can be increased (by the SET FULL SCALE adjustment) to allow for the voltage drop across the recorder. For a 1000-ohm recorder, +E should be +16 volts for proper full-scale reading. The linearity of the output is not affected by the impedance of the recorder.

TABLE 2
SWITCH CURRENTS

S1	100 μa	
S2	200 μa	100's decade
S3	400 μa	total 900 μa
S4	200 μa	
S5	10 μa	
S6	20 μa	10's decade
S7	40 μa	total 90 μa
S8	20 μa	
S9	1 μa	
S10	2 μa	1's decade
S11	4 μa	total 9 μa
S12	2 μa	

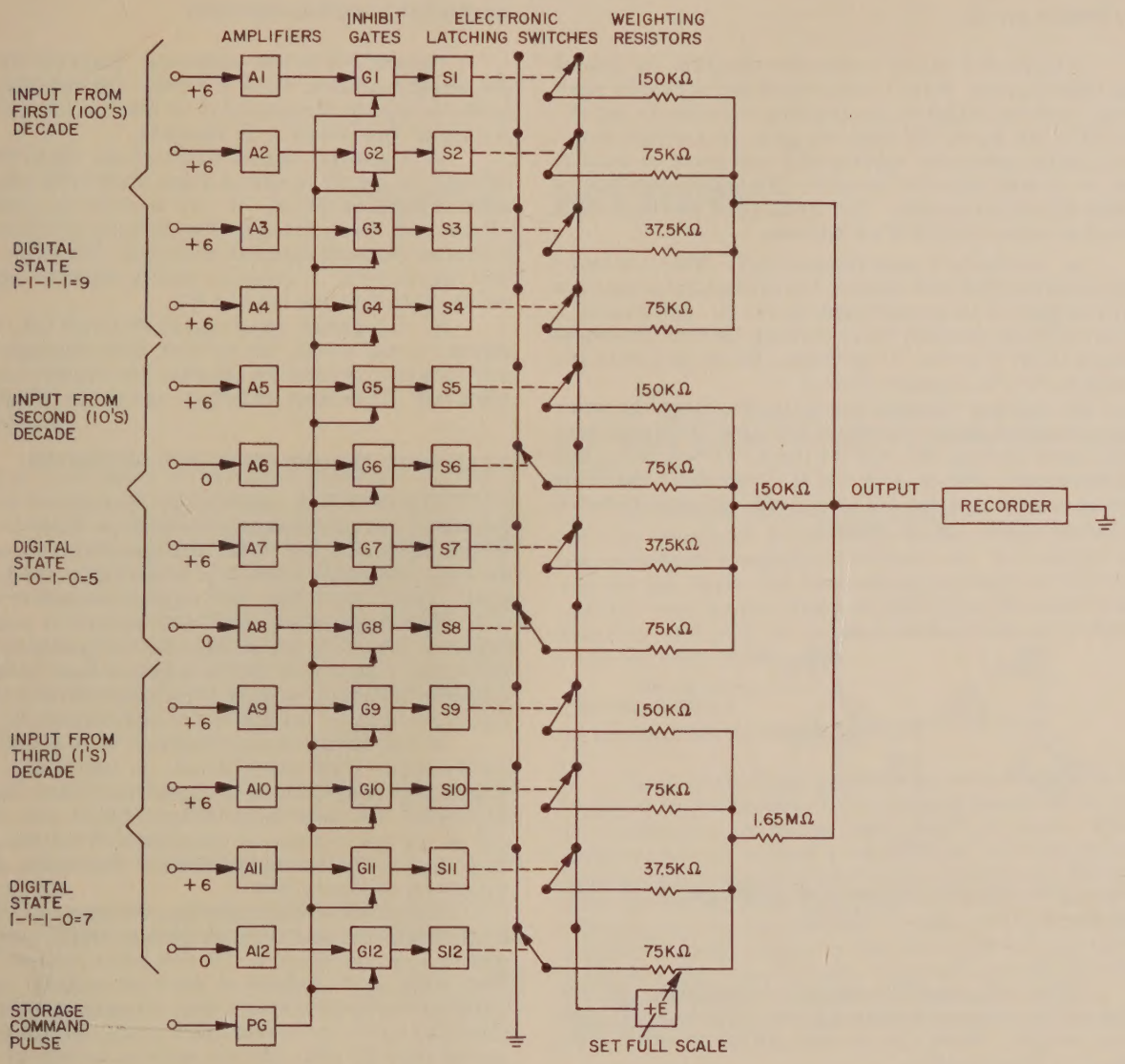


Figure 2-1. Simplified schematic diagram of the Type 1136-A with an input of 957.

2.2 INPUT AMPLIFIERS.

Figure 2-2 is a detailed schematic diagram of one of the input amplifiers. The input network, R1 and R2, permits offset of the binary-0 level from 0 volt. The binary-1 level must be at least 6 volts more positive than the binary-0 level into 50-kilohm input impedance. The required bias voltage for optimum sensitivity can be determined as follows:

$$E_B = -2E_0 - 3 \text{ volts}$$

where E_B is the bias voltage,

E_0 is the binary-0 level.

If E_0 is more positive than -1.5 volts, E_B is negative. These conditions ensure that Q1 is off for a binary 0 and on (saturated) for a binary 1.

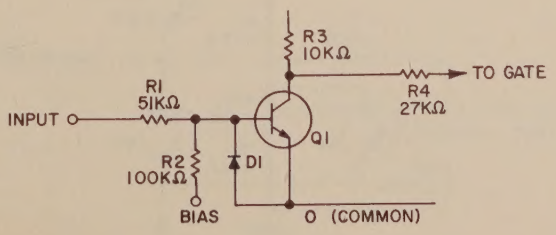


Figure 2-2. Schematic diagram of an input amplifier of the Type 1136-A.

2.3 INHIBIT GATES.

Figure 2-3 is the schematic diagram for one of the inhibit gates. Point A and point B are normally near 0 volt and the output to the latching switches is not affected by the input. To open the gate, the storage-command pulse generator applies +23-volt pulse to point A and a -5-volt pulse to point B. The pulse duration is about 30 microseconds. The transfer of the input data into the output switch is as follows:

a. A binary-1 input saturates Q1. When the storage-command pulse is applied, the base of Q2 is negative with respect to its emitter, and Q2 is off. Since point A is at +23 volts, current flows through R6 into the output switch to set it to the "1" position. (If the switch is already at "1", it remains there.)

b. A binary-0 input turns Q1 off. When the storage-command pulse is applied, the base of O2 gets forward bias through R3 and R4 from +23-volt pulse and Q2 saturates. The collector of Q2 has nearly the same voltage as the emitter (-5 volts) and the output switch is turned off (to the "0" state).

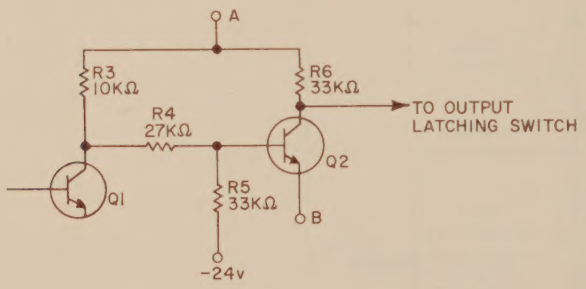


Figure 2-3. Schematic diagram of an inhibit gate of the Type 1136-A.

Thus a "jammed" transfer is obtained, i.e., the state of the output switches changes only when the input data changes. There are no reset pulses to either state before a data transfer.

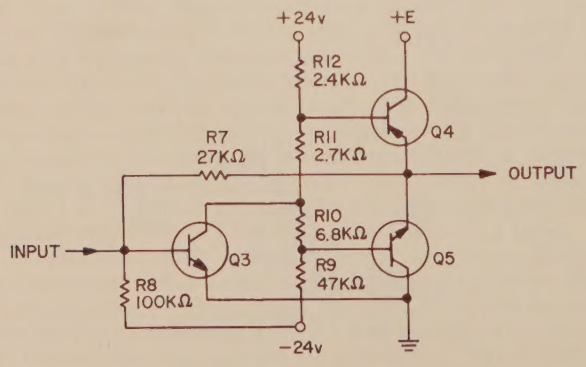


Figure 2-4. Schematic diagram of an output switch of the Type 1136-A.

2.4 OUTPUT LATCHING SWITCHES

Figure 2-4 is the schematic diagram for one of the output switches. Q3 is a driver. Q4 and Q5 are used in the inverted configuration to ensure low saturation voltages. Operation is as follows:

a. A positive signal turns Q3 on. Q4 is on, Q5 is off, and the output is within a few millivolts (the saturation voltage of Q4) of +E. As soon as the output is at +E, current flows through R7 to the base of Q3 and keeps it on after the input signal is removed. The output switch will stay in this "1" position until a negative input signal is applied to the base of R3.

b. A negative input signal turns off Q3, then the output is near 0 volt. No current flows through R7. R8 provides cut-off bias for Q3 after the negative signal is removed. The output switch is now in the "0" position.

2.5 STORAGE-COMMAND PULSE (SCP) GENERATOR.

Figure 4-5 is a schematic diagram of the pulse generator and power supply of the Type 1136-A Digital-to-Analog Converter. The SCP generator consists of an input amplifier (Q401), a monostable multivibrator (Q402, Q403, and Q404), and another amplifier Q405).

The input amplifier, Q401, accepts a positive or negative pulse. If the input pulse is positive, S401 is set to the + position. For a negative input pulse, S401 connects the input amplifier as an inverter to provide a positive trigger for the monostable multivibrator.

In the steady-state condition of the monostable multivibrator Q403 and Q404 are on and Q402 is cut off. The collector of Q402 is clamped near 0 volt by CR403. This point connects to point A in Figure 2-3. Q405 is cut off and its emitter is clamped to 0 volt by the forward-biased Zener diode, CR405. This point connects to point B in Figure 2-3.

A positive pulse applied to the base of Q403 turns it off and the current through Q404 is interrupted. Q402 turns on and produces a +23-volt pulse at its collector. This pulse also appears at the base of Q404 and holds Q404 off for about 30 μsec (this time is determined by C403 and R408). As long as Q404 is off, Q405 is forward-biased through R411 and the emitter voltage of Q405 is determined by Zener diode, CR405. This Zener voltage is about 5 volts and controls the amplitude of the negative pulse to point B in Figure 2-3.

2.6 POWER SUPPLY.

Transistors Q501, Q502, and Q503 (see Figure 4-6) are in a series-regulator circuit that provides +24 volts. R503 permits adjustment of this voltage.

Transistors Q504, Q505, Q506, and Q507 are in a series-regulator circuit that supplies a stabilized voltage for the output switches (+E in Figure 2-4). The output voltage is varied by the SET FULL SCALE panel controls.

Transistor Q508, with Zener diodes CR508 and CR509, supplies about -24 volts. R529 supplies an adjustable voltage for the input bias (see Figure 2-2). J501 (on the rear skirt of the instrument) permits checking with a 20,000 ohms volt multimeter or vacuum-tube voltmeter. The voltage range is about 0 to -6 volts.

SECTION 3

OPERATING PROCEDURE

3.1 MOUNTING.

The instrument is available equipped for either bench or relay-rack mounting. For bench mounting (Type 1136-AM) aluminum end frames are supplied to fit the ends of the cabinet. Each end frame is attached to the instrument with one panel screw and four No. 10-32 round-head screws with notched washers.

For rack mounting (Type 1136-AR), special rack-mounting brackets are supplied to attach the cabinet and instrument to the relay rack (see Figure 3-1). These brackets permit either cabinet or instrument to be withdrawn independently of the other.

To install the instrument in a relay rack:

a. Attach each mounting bracket (A) to the rack with two No. 12-24 round-head screws (B). Use the inside holes on the brackets.

b. Slide the instrument onto the brackets as far as it will go.

c. Insert the two panel screws with attached washers (C) through the panel and the bracket and thread them into the rack.

d. Toward the rear of each bracket, put a thumb screw (D) through the slot in the bracket and into the hole in the side of the cabinet.

e. On the rear of the cabinet, remove the two round-head screws that hold the cabinet to the instrument.

To remove the instrument from the rack, remove only the two panel screws with washers (C) and draw the instrument forward out of the rack. To remove the cabinet and leave the instrument mounted in the rack, remove only the two thumb screws (D) at the rear of the brackets and pull the cabinet back off the instrument from the rear of the rack.

3.2 CONNECTION TO POWER SUPPLY.

Connect the Type 1136-A to a source of power as indicated by the legend at the input socket at the rear of the instrument, using the power cord provided. While instruments are normally supplied for 115-volt operation, the power transformer can be reconnected for 230-volt service (see schematic diagram, Figure 4-2). When changing connections, be sure to replace line fuses with those of current rating for the new input voltage (refer to Parts List). Appropriate measures should be taken so that the legend indicates the new input voltage. On instruments changed from 230 to 115 volts, this simply

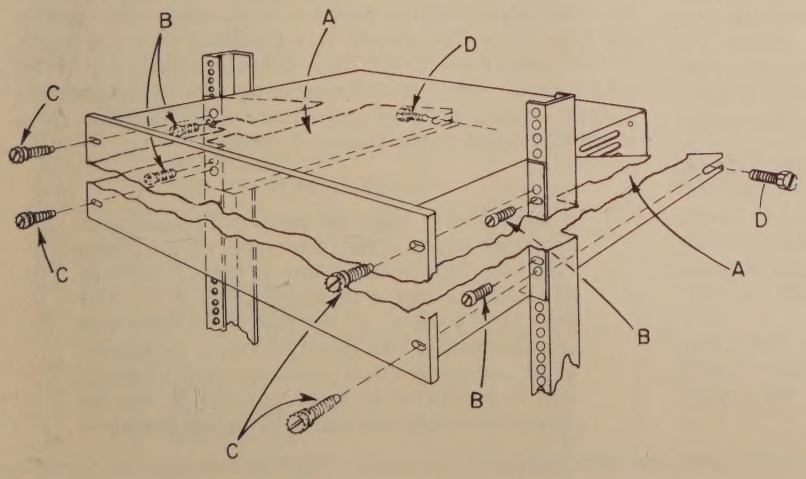


Figure 3-1. Installation of relay-rack model, Type 1136-AR.

means removal of the 230-v nameplate; a 115-v legend is marked beneath. For instruments changed to 230 volts, a nameplate (Type 5590-1664) may be ordered from General Radio.

3.3 CONNECTION OF DIGITAL INPUT.

The Type 1136-P1 Cable is available for connection to the Type 1150-AP and Type 1151-AP counters. As other General Radio digital instruments become available, special cables for connection to the Type 1136-A Digital-to-Analog Converter will also be available. If any adjustment of the converter is required, information will be supplied with the cable. For connection with digital sources of other manufacture, refer to paragraph 3.7.

3.4 OUTPUT CONNECTION.

Connect a recorder to the output terminals. For the 1-ma output from the converter, recorders with 1-ma full-scale value and up to 2500-ohm impedance may be used. The 100-mv output is intended for potentiometer-type recorders but recorders with impedances as low as 1000 ohms can be used.

3.5 NUMERAL POSITION SWITCH.

The NUMERAL POSITION switch selects any adjacent three, or the last two, of up to nine-decades connected to the input. The position of this switch is indicated by illuminated numbers. Number 1 corresponds to the most significant decade of the source, the extreme left-hand digit on any counter display. Any three decades will form an analog output which has 0.1% increments (1000 steps). If the last two decades are selected, the output has 1% increments (100 steps).

3.6 CALIBRATION.

To calibrate the Type 1136-A Digital-to-Analog Converter, introduce 9's into the two or three decades selected. If the digital source (e.g., a counter) has no SET 9 switch, a suitable external signal (one which produces a 999 or 99 reading) must be counted. After the decades of the digital source read correctly (999 or 99), with the SET FULL SCALE controls of the Type 1136-A, set the recorder indication to 99.9% of full scale if three decades are selected or to 99% of full scale if the last two decades were selected. If no suitable means are available to introduce 9's into the converter, any other reading (the nearer full scale, the better) can be used by setting the recorder reading to agree with the counter display.

If no output can be obtained from the Type 1136-A, check that the polarity switch for the storage-command pulse (on the rear skirt of the Type 1136-A) is in the correct position and that the reference-voltage control (on the rear skirt) is adjusted properly. The correct polarity and voltage settings are supplied with the connecting cables.

The Type 1136-A Digital-to-Analog Converter does not require any zero adjustment. The zero drift of the Type 1136-A is less than 0.05% under all operating conditions.

3.7 USE WITH EQUIPMENT NOT MANUFACTURED BY GENERAL RADIO.

3.7.1 LOGIC LEVELS. The design of the Type 1136-A provides exceptional flexibility of input conditions. Any BCD source which provides a binary-1 level at least 6 volts more positive than the binary-0 level, and a weighting of either 1-2-2-4 or 1-2-4-2 will drive the Type 1136-A. The binary-0 level can be +1.5 to -1.5 volts with the internal bias supply. If the binary-0 level is outside this range, an external bias supply can be used. The bias voltage required can be determined as follows:

1. The binary-0 input level, E_0, must keep the input transistor off so the bias voltage, E_B, must be equal to or more negative than $(-3 - 2E_0)$ volts.
2. The binary-1 input level, E_1, must saturate the input transistor so the bias voltage, E_B, must be equal to or more positive than $(+6 - 2E_1)$ volts.

Both conditions may be written as:

$$+6 - 2E_1 \leq E_B \leq -3 - 2E_0$$

Example 1: $E_0 = 0$ and $E_1 = +6$

Then, $+6 - 2(+6) \leq E_B \leq -3 - 2(0)$

$$-6 \leq E_B \leq -3$$

For binary inputs of 0 and +6 volts, the permissible bias range is from -6 to -3 volts. The optimum bias is -4.5 volts (the center of the range).

Example 2: $E_0 = -10$ and $E_1 = +10$

Then, $+6 - 2(+10) \leq E_B \leq -3 - 2(-10)$

$$-14 \leq E_B \leq +17$$

This means that any bias from -14 to +17 volts will be satisfactory, and 0 volt may be chosen for convenience.

In general, binary-0 levels from +20 to -20 volts can be accepted with this bias method. The load on the bias supply is about 8 kilohms. If a bias voltage more positive than -3 volts is used, any bit without input connection (open-circuit) will assume the binary-1 state. This condition may be encountered when the last two digits of the input data are selected. In this case, the last decade of the standardizer is not normally connected to any input and the positive bias supply will turn on all four bits. The result is a constant output of +0.9% of full scale for 1-2-4-2 or 1-2-2-4 weighting, or +1.5% of full scale for 1-2-4-8 weighting. To eliminate this output, connect the four input lines of the last decade to a voltage equal to the binary-0 level.

EXAMPLE

A source with eight decades is connected to the first eight input positions of the Type 1136-A. This source has a binary-0 level of -10 volts and a binary-1 level of 0. The bias is +10 volts. If the last two digits are to be converted into 1% output steps, the standardizer decade which produces the 0.1% steps and is connected to input position 9, has no input connection and will assume the binary-1

state. However, if the four input lines of position 9 are connected to -10 volts, all bits will remain in the binary-0 state and no output will be produced.

The unused bits need not be connected to a binary-0-level voltage if the bias is more negative than -3 volts or if there is no need to select the last two digits. As long as any three digits are selected, the condition described above cannot exist.

Large offset (to ±150 volts) can be obtained by disconnecting the low side of the output from ground (remove the jumper, see Figure 4-2) and applying the offset voltage between this low terminal and ground. In this case, the recorder cannot be grounded. Internal bias of -3 volts should be used for any offset voltage. The external offset supply should apply the voltage of the binary-0 level to the "low" terminal with respect to ground.

Example: E_0 = +120 volts, then the low terminal should be on +120 volts with respect to the ground (chassis).

3.7.2 BCD WEIGHTING AND 10-LINE DECIMAL INPUT. Basically the Type 1136-A Digital-to-Analog Converter is designed for BCD weighting of 1-2-4-2. However, since data are introduced by parallel entry, the 1-2-2-4 weighting requires no change in the Type 1136-A. The different weighting is obtained by proper input connections.

To use the Type 1136-A Converter with BCD 1-2-4-8 weighting, the weighting resistor in the 4th bit of each decade of the Converter must be changed as follows:

a. Change R23D from 75 kilohms 0.1% to 18.75 kilohms ±0.05% with less than ±10 ppm temperature coefficient.

b. Change R23H from 75 kilohms ±1% to 18.75 kilohms ±0.5%.

c. Change R23M from 75 kilohms ±5% composition-type to 18.7 kilohms ±1% carbon-film type.

d. Change R24E from 150 kilohms ±0.25% to 90 kilohms ±0.25%.

e. Change R24J from 1.65 megohms ±1% to 990 kilohms ±1%.

TABLE 3
INPUT-CONNECTOR (S0101) TERMINALS

TERMINAL	WIRE COLOR	FUNCTION Bit Weighting	FUNCTION Decade	TERMINAL	WIRE COLOR	FUNCTION Bit Weighting	FUNCTION Decade
B1	BR	1	1	B7	VT	1	7
D1	WH-BR	2	1	D7	WH-VT	2	7
F1	WH-BL-BR	4	1	F7	WH-RD-BR	4	7
H1	WH-GY-BL	2	1	H7	WH-VT-BL	2	7
A2	RD	1	2	A8	GY	1	8
C2	WH-RD	2	2	C8	WH-GY	2	8
E2	WH-GN-BL	4	2	E8	WH-RD-BK	4	8
G2	WH-VT-BK	2	2	G8	WH-VT-BR	2	8
B2	OR	1	3	B9	WH	1	9
D3	WH-OR	2	3	D9	WH-BR-BK	2	9
F3	WH-RD-BL	4	3	F9	WH-GY-BK	4	9
H3	WH-VT-GN	2	3	H9	WH-VT-GY	2	9
A4	YEL	1	4	H13	BK	Common (Ground)	
C4	WH-YEL	2	4				
E4	WH-RD-GN	4	4				
G4	WH-VT-RD	2	4	D13	WH-BL-BK	Bias input	
B5	GN	1	5				
D5	WH-GN	2	5				
F5	WH-GN-BR	4	5	B13	WH-BK	Storage - command - pulse input	
H5	WH-GY-RD	2	5				
A6	BL	1	6				
C6	WH-BL	2	6	F13	WH-GY-BR	Internal -bias-supply output	
E6	WH-GN-BK	4	6				
G6	WH-GY-GN	2	6				

Ten-line decimal input data can be converted into BCD data by means of a diode matrix. A five-decade diode matrix is used to connect General Radio Type 1150-AP and Type 1151-AP frequency meters, which have 10-line decimal output, to the Type 1136-A. These matrices convert the 10-line decimal output to BCD output with 1-2-4-2 weighting. This matrix is supplied as part of the Type 1136-P1 connecting cable. The unit also contains a delay generator to make the "print command pulse" of the Type 1150 series counters suitable for the Type 1136.

3.7.3 STORAGE-COMMAND PULSE. To effect transfer of the input data into storage, a pulse is required at a time when the input data are not changing. Most counters provide a pulse to drive printers (the print-command pulse) which is generally suitable to drive the Type 1136-A.

3.7.4 INPUT CONNECTIONS. All input connections are made through S0101 (on the rear skirt of the Type 1136-A). The mating connector for S0101 is General Radio Type 4220-5302 or Amphenol Type 220-37-01. Special tools are required to crimp the wires to the mating connector. To facilitate connection to special input sources, a cable with this connector on one end and loose wires on the other end is available on special order. Should you prefer to make your own cable, Table 3 shows the connection and function of each color-coded wire inside the instrument. Make appropriate connections to the mating connector on your cable. If the internal bias source is to be used, D13 and F13 must be connected. Splice the appropriate wires together.

The NUMERAL POSITION switch selects any adjacent three, or the last two, decades. It connects the standardizer with the 100's weighting to the extreme left-hand decade of the two or three selected.

Example: NUMERAL POSITION 3-4-5

Then, the third decade provides 10% increments,
the fourth decade provides 1% increments,
the fifth decade provides 0.1% increments.

SECTION 4 SERVICE AND MAINTENANCE

4.1 WARRANTY

We warrant that each new instrument sold by us is free from defects in material and workmanship, and that, properly used, it will perform in full accordance with applicable specifications for a period of two years after original shipment. Any instrument or component that is found within the two-year period not to meet these standards after examination by our factory, district office, or authorized repair agency personnel, will be repaired or, at our option, replaced without charge, except for tubes or batteries that have given normal service.

4.2 SERVICE

The two-year warranty stated above attests the quality of materials and workmanship in our products. When difficulties do occur, our service engineers will assist in any way possible. If the difficulty cannot be eliminated by use of the following service instructions, please write or phone our Service Department (see rear cover), giving full information of the trouble and of steps taken to remedy it. Be sure to mention the serial and type numbers of the instrument.

Before returning an instrument to General Radio for service, please write to our Service Department or nearest district office, requesting a Returned Material Tag. Use of this tag will ensure proper handling and identification. For instruments not covered by the warranty, a purchase order should be forwarded to avoid unnecessary delay.

4.3 VOLTAGE MEASUREMENTS

Table 4 gives dc voltages measured from transistor terminals to J102 (common) with a vacuum-tube voltmeter, with an input line voltage of 115 volts, and the SET FULL SCALE control on the Type 1136-A set fully counter clockwise. Voltages marked with an asterisk are measured with test points 1 and 2 shorted. For measurements in the standardizer circuits, the bias input is connected to the internal bias supply, and voltages are given for both "0" (binary-0) and "1" (binary-1) states.

TABLE 4
TRANSISTOR VOLTAGES

TRANSISTOR (TYPE)	DC VOLTS TO J102 FROM COLLECTOR	EMITTER	BASE
POWER SUPPLY			
Q501 (2N696)	25.2	12.0	12.6
Q502 (2N696)	32.0	24.6	25.2
Q503 (2N2196)	32.0	24.0	24.6
Q504 (2N1131)	15.0	24.0	23.4
Q505 (2N190)	15.0	11.4	12.0
Q506 (2N190)	21.0	11.4	12.0
Q507 (SA2022)	12.0 12.0	8.8	9.4 9.4
Q508 (2N1131)	-33.0	-24.0	-24.6
SCP GENERATOR			
Q401 (2N910)	17.0	3.4	4.0
Q402 (2N1131)	-0.5 (23.0)*	23.8 (23.2)*	23.4 (22.5)*
Q403 (2N1303)	24.0 (7.1)*	24.0 (24.0)*	23.8 (24.0)*
Q404 (2N1131)	23.3 (7.1)*	23.3 (7.1)*	22.7 (6.5)*
Q405 (2N1303)	-24.0 (-4.6)*	0.7 (-4.5)*	1.2 (-4.8)*
STANDARDIZER CIRCUITS			
Q11A through Q11M (2N910)	"0" — 15.5* "1" — 0.1*	"0" — 0* "1" — 0*	"0" — -0.41* "1" — -0.6*
Q12A through Q12M (2N1302)	"0" — -4.5* "1" — -0.2*	"0" — -4.5* "1" — -4.5*	"0" — -4.4* "1" — -11.0*
Q13A through Q13M (2N1302)	"0" — 13.8* "1" — 0*	"0" — 0* "1" — 0*	"0" — -4.5* "1" — 0.2*
Q14A through Q14M (2N1303)	"0" — 15.0* "1" — 15.0*	"0" — 0* "1" — 15.0*	"0" — 19.2* "1" — 14.8*
Q15A through Q15M (2N1302)	"0" — 0* "1" — 0*	"0" — 0* "1" — 15.0*	"0" — 0.2* "1" — -3.0*

*Measured with test points 1 and 2 shorted.
"0" — Circuits in binary-0 state.
"1" — Circuits in binary-1 state.

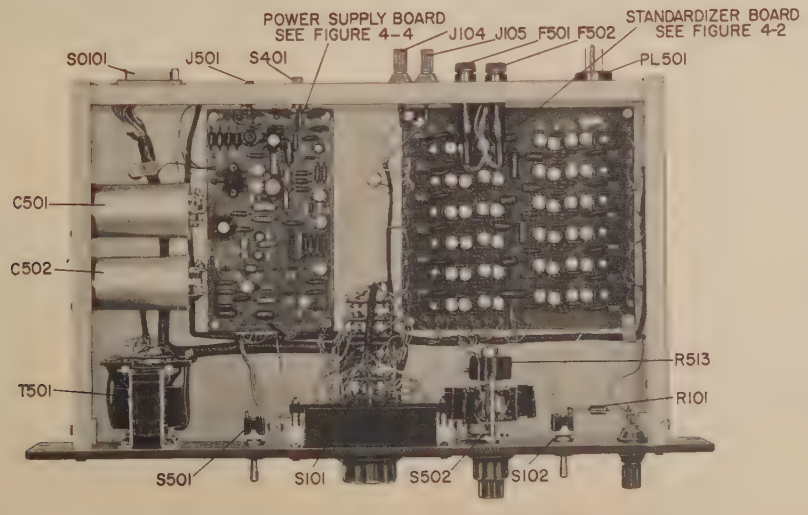


Figure 4-1. Top interior view of the Type 1136-A.

PARTS LIST

REF NO.	DESCRIPTION	PART NO.
R11A thru R11M*	RESISTOR, Composition, 51kΩ ±5% 1/4w	6099-3515
R12A thru R12M*	RESISTOR, Composition, 100kΩ ±5% 1/4w	6099-4105
R13A thru R13M*	RESISTOR, Composition, 10kΩ ±5% 1/4w	6099-3105
R14A thru R14M*	RESISTOR, Composition, 27kΩ ±5% 1/4w	6099-3275
R15A thru R15M*	RESISTOR, Composition, 33kΩ ±5% 1/4w	6099-3335
R16A thru R16M*	RESISTOR, Composition, 33kΩ ±5% 1/4w	6099-3335
R17A thru R17M*	RESISTOR, Composition, 27kΩ ±5% 1/4w	6099-3275
R18A thru R18M*	RESISTOR, Composition, 100kΩ ±5% 1/4w	6099-4105
R19A thru R19M*	RESISTOR, Composition, 47kΩ ±5% 1/4w	6099-3475
R20A thru R20M*	RESISTOR, Composition, 6.8kΩ ±5% 1/4w	6099-2685
R21A thru R21M*	RESISTOR, Composition, 2.7kΩ +5% 1/4w	6099-2275
R22A thru R22M*	RESISTOR, Composition, 2.4kΩ ±5% 1/4w	6099-2245
R23A	RESISTOR, Precision, 150kΩ ±1/4% 1/4w	6731-4150
R23B	RESISTOR, Precision, 75kΩ ±0.1% 1/2w	6730-4751
R23C	RESISTOR, Precision, 37.5kΩ ±0.05% 1/2w TC ±10ppm	6739-2375
R23D	RESISTOR, Precision, 75kΩ ±0.1% 1/2w	6730-4751
R23E	RESISTOR, Film, 150kΩ ±1% 1/8w	6250-3150
R23F	RESISTOR, Precision, 75kΩ ±1% 0.3w	6730-3750
R23G	RESISTOR, Precision, 37.5kΩ ±0.5% 1/2w	6730-2375
R23H	RESISTOR, Precision, 75kΩ ±1% 0.3w	6730-3750
R23J	RESISTOR, Composition, 150kΩ ±5% 1/2w	6100-4155
R23K	RESISTOR, Composition, 75kΩ ±5% 1/2w	6100-3755
R23L	RESISTOR, Film, 37.4kΩ ±1% 1/8w	6250-2374
R23M	RESISTOR, Composition, 75kΩ ±5% 1/2w	6100-3755
R24E	RESISTOR, Precision, 150kΩ ±1/4% 1/4w	6731-4150
R24J	RESISTOR, Film, 1.65MΩ ±1% 1/4w	6350-4165
R101	RESISTOR, Precision, 100Ω ±1% 0.3w TC ±10ppm	6739-1101
C11A thru C11M*	CAPACITOR, Ceramic, 0.001 µf ±10% 500dcwv	4406-2108
C11N	CAPACITOR, Plastic, 0.022µf ±10% 100v	4860-7860
CR11A thru CR11M*	DIODE, Type 1N645	6082-1016
J101	BINDING POST, Insulated, 100-mv Output	4060-0400
J102	BINDING POST, Insulated, 1-ma Output	4060-0410
J103	BINDING POST, Uninsulated, Ground	4060-1800
J104	BINDING POST, Insulated, 100-mv Output	4060-0400
J105	BINDING POST, Insulated, 1-ma Output	4060-0410
Q11A thru Q11M*	TRANSISTOR, Type 2N910	8210-1037
Q12A thru Q12M*	TRANSISTOR, Type 2N1302	8210-1018
Q13A thru Q13M*	TRANSISTOR, Type 2N1302	8210-1018
Q14A thru Q14M*	TRANSISTOR, Type 2N1303	8210-1019

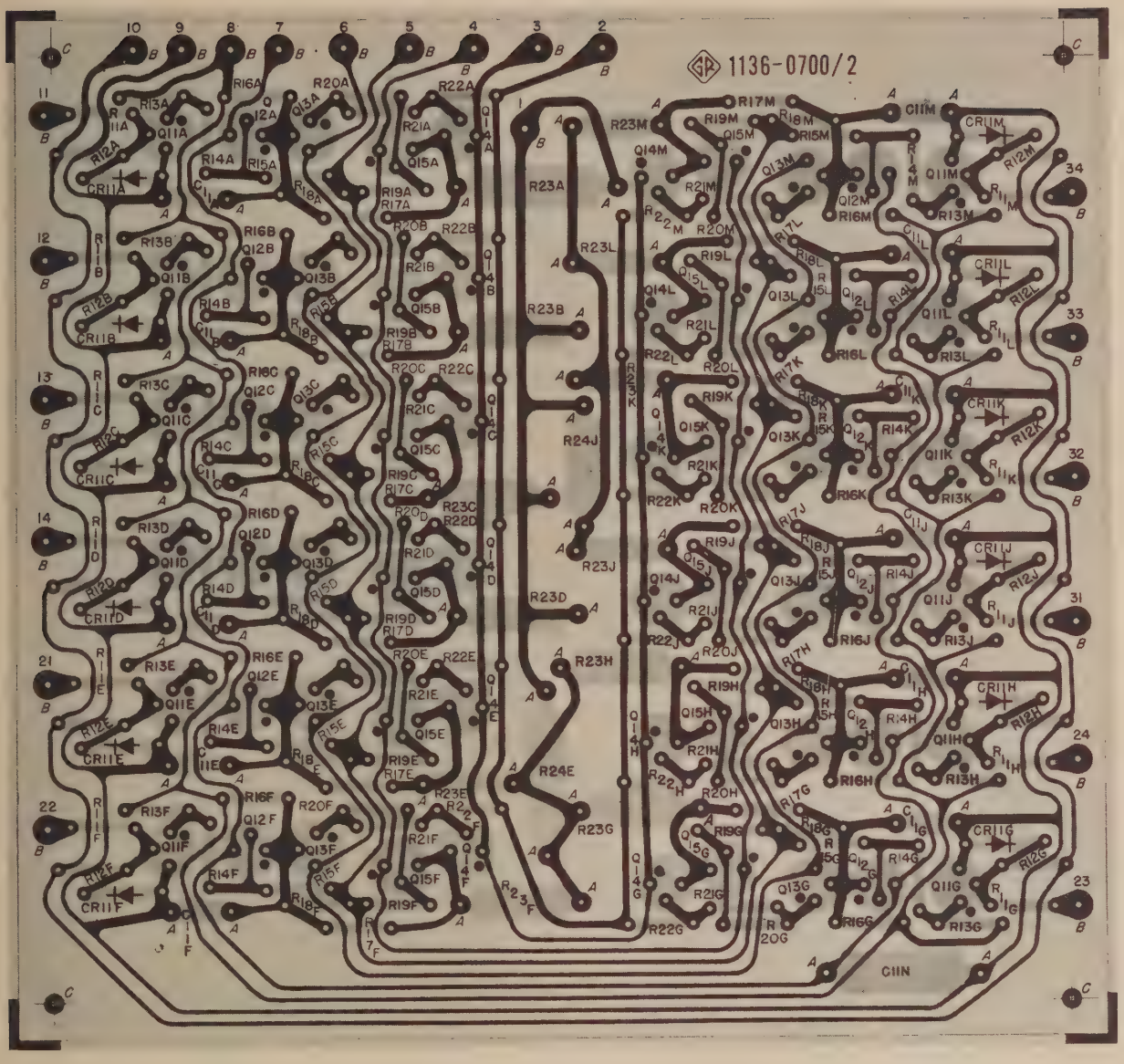
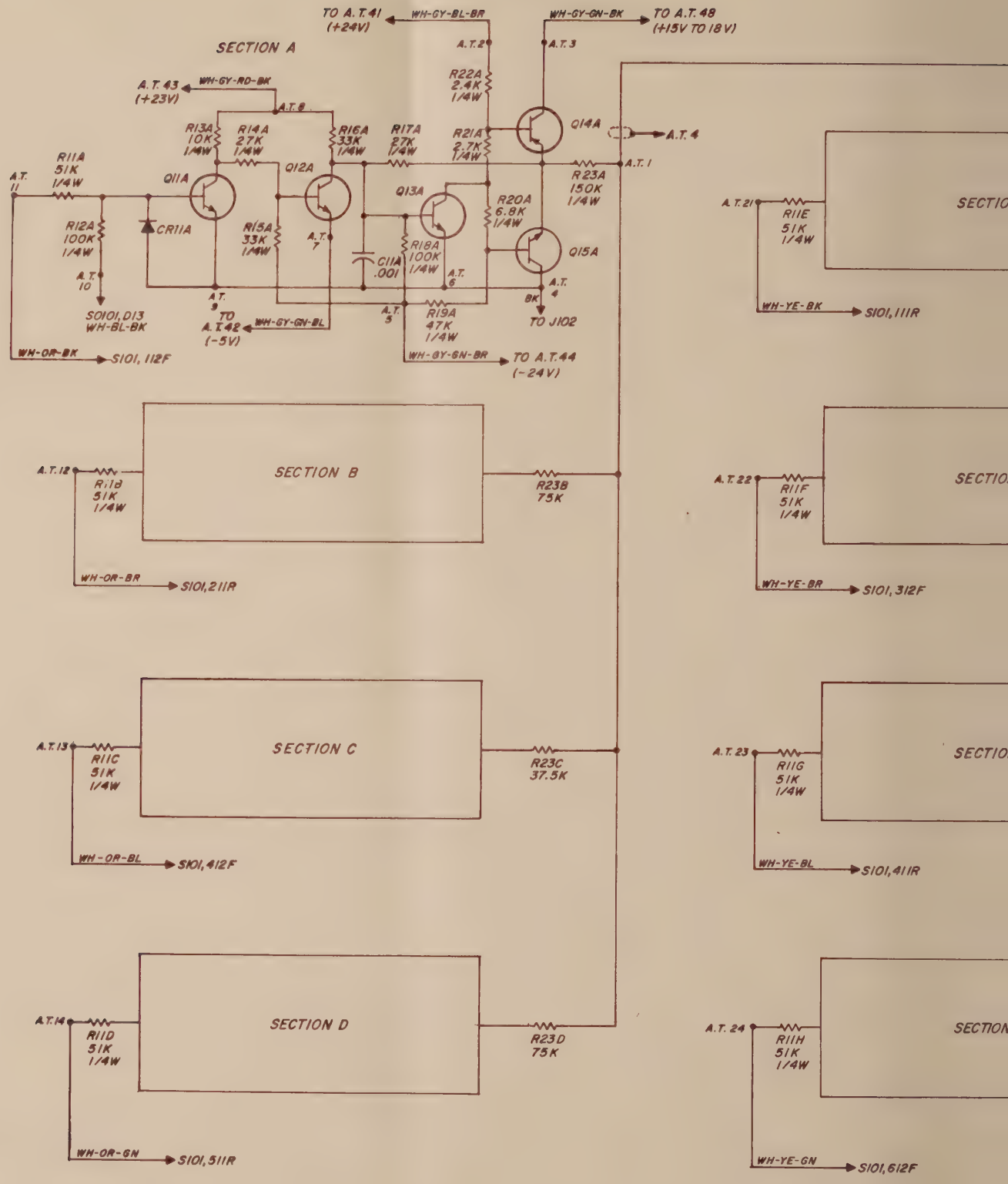


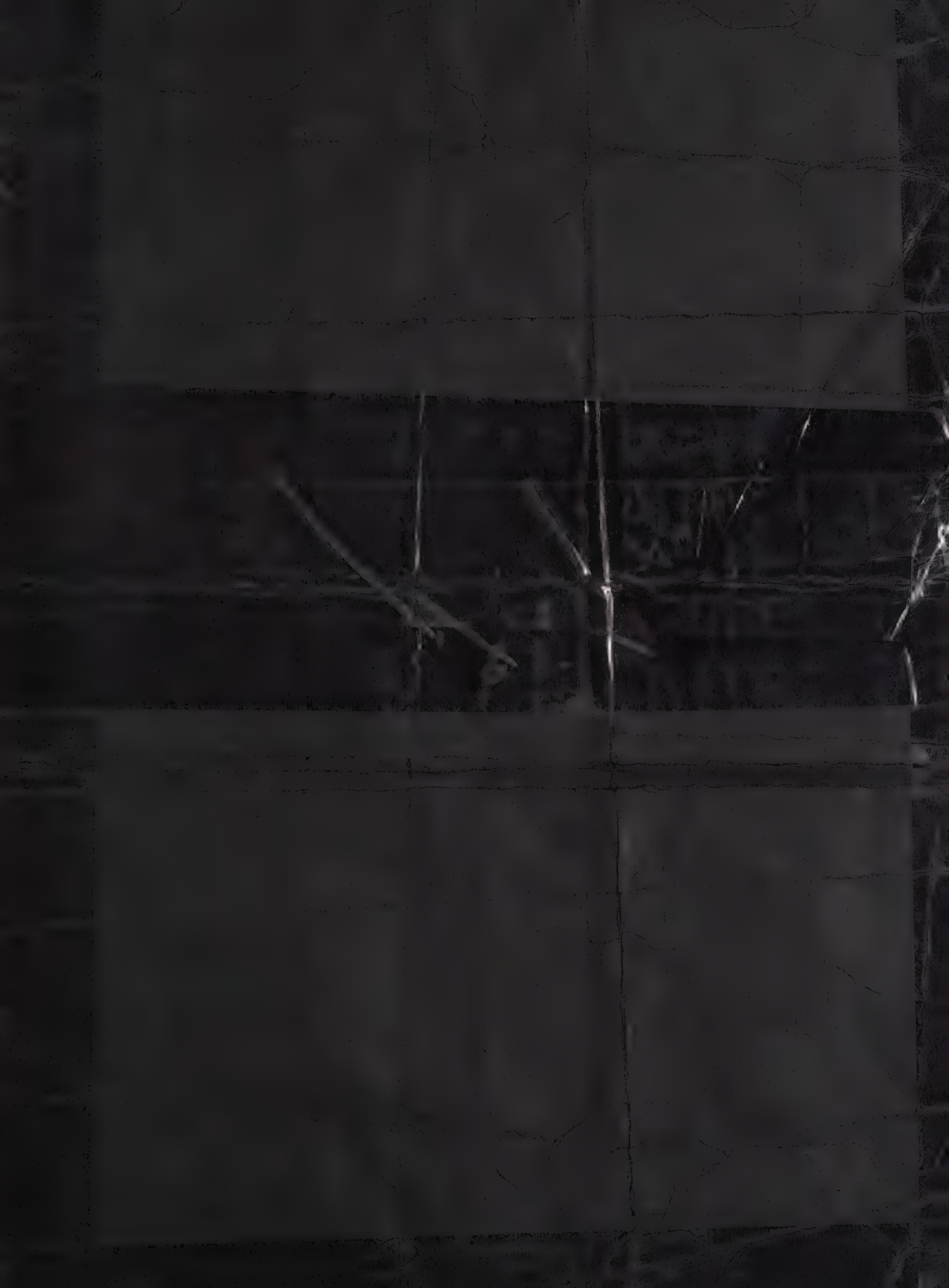
Figure 4-2. Etched-board layout of standardizer.

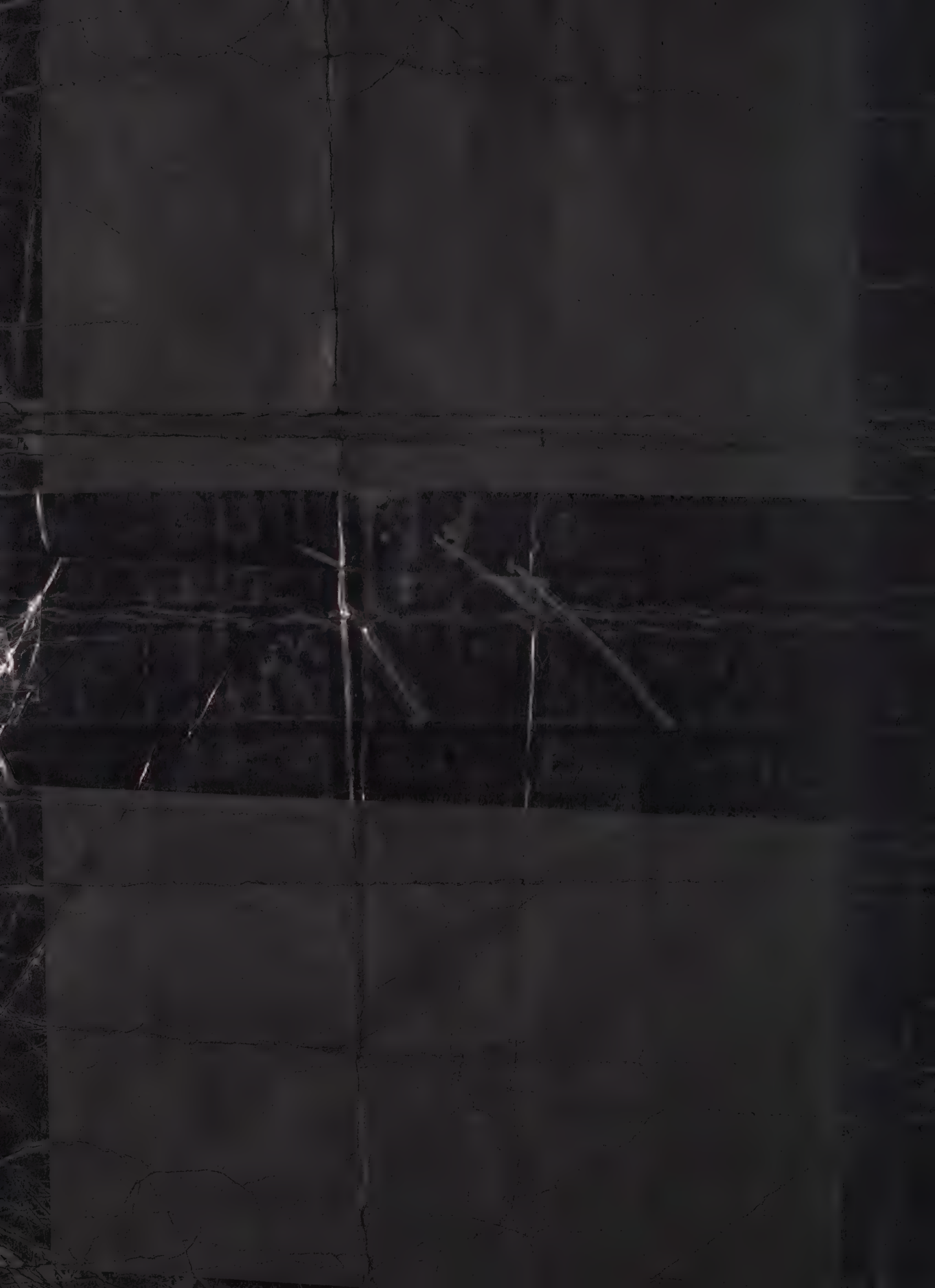
PARTS LIST (continued).

REF NO.	DESCRIPTION	PART NO.
Q15A thru Q15M*	TRANSISTOR, Type 2N1302	8210-1018
S101	SWITCH, Rotary Wafer	7890-3390
S102	SWITCH	7910-1000
S0101	SOCKET	4230-5000
V101	LAMP, Type 2LAP-9	5600-0309
V102	LAMP, Type 2LAP-9	5600-0309
V103	LAMP, Type 2LAP-9	5600-0309
V104	LAMP, Type 2LAP-9	5600-0309
V105	LAMP, Type 2LAP-9	5600-0309
V106	LAMP, Type 2LAP-9	5600-0309
V107	LAMP, Type 2LAP-9	5600-0309
V108	LAMP, Type 2LAP-9	5600-0309
V109	LAMP, Type 2LAP-9	5600-0309

*"I" not used, 12 components


SECTION A
TO A.T. 41 (+24V)
WH-GY-BL-BR
WH-GY-GN-BK
TO A.T. 48 (+15V TO 18V)
A.T. 43 (+23V)
WH-GY-RD-BK
A.T. 2
A.T. 3
A.T. 8
R22A 2.4K 1/4W
R13A 10K 1/4W
R14A 27K 1/4W
R16A 33K 1/4W
R17A 27K 1/4W
R21A 2.7K 1/4W
Q14A
A.T. 4
A.T. 1
R23A 150K 1/4W
R11A 51K 1/4W
A.T. 11
Q11A
Q12A
Q13A
R20A 6.8K 1/4W
Q15A
R12A 100K 1/4W
CR11A
R15A 33K 1/4W
A.T. 7
C11A .001
R18A 100K 1/4W
A.T. 6
A.T. 10
A.T. 9
A.T. 5
R19A 47K 1/4W
A.T. 4
BK
S0101, D13 WH-BL-BK
TO A.T. 42 (-5V)
WH-GY-GN-BL
TO J102
WH-OR-BK
S101, 112F
WH-GY-GN-BR
TO A.T. 44 (-24V)
A.T. 21
R11E 51K 1/4W
SECTIO
WH-YE-BK
S101, 111R
A.T. 12
R11B 51K 1/4W
SECTION B
R23B 75K
WH-OR-BR
S101, 211R
A.T. 22
R11F 51K 1/4W
SECTIO
WH-YE-BR
S101, 312F
A.T. 13
R11C 51K 1/4W
SECTION C
R23C 37.5K
WH-OR-BL
S101, 412F
A.T. 23
R11G 51K 1/4W
SECTIO
WH-YE-BL
S101, 411R
A.T. 14
R11D 51K 1/4W
SECTION D
R23D 75K
WH-OR-GN
S101, 511R
A.T. 24
R11H 51K 1/4W
SECTION
WH-YE-GN
S101, 612F





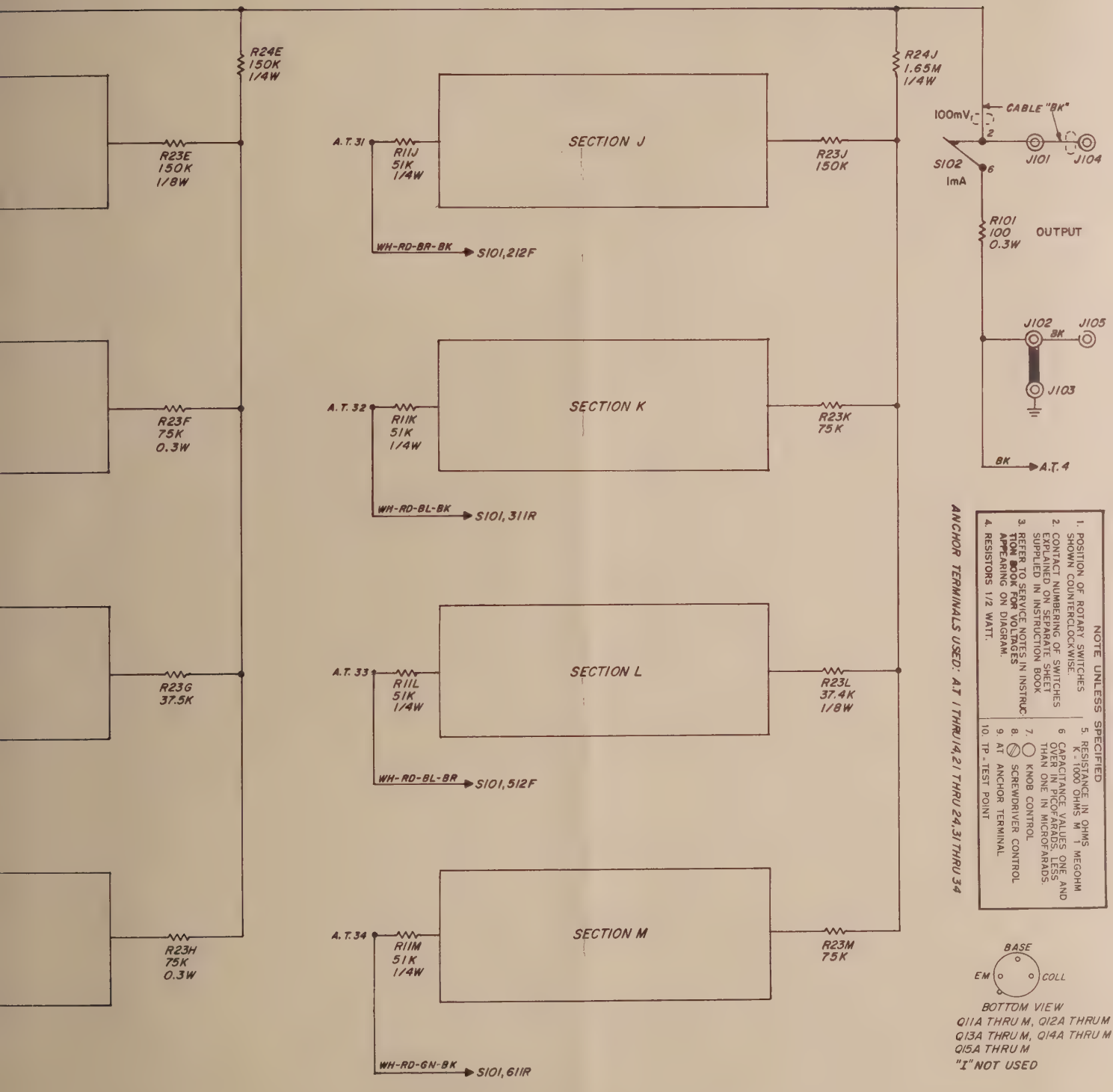


Figure 4-3. Schematic diagram for standardizer circuits.

PARTS LIST

REF NO.	DESCRIPTION	PART NO.
R501	RESISTOR, Composition, 2kΩ ±5% 1/2w	6100-2205
R502	RESISTOR, Film, 1kΩ ±1% 1/4w	6350-1100
R503	POTENTIOMETER, Wire-Wound, 500Ω ±5%	6058-1505
R504	RESISTOR, Film, 1kΩ ±1% 1/4w	6350-1100
R505	RESISTOR, Composition, 1.3kΩ ±5% 1/2w	6100-2135
R506	RESISTOR, Composition, 3.9kΩ ±5% 1/2w	6100-2395
R507	RESISTOR, Film, 4.99kΩ ±1% 1/8w	6250-1499
R508	RESISTOR, Film, 665Ω ±1% 1/4w	6350-0655
R509	RESISTOR, Film, 12.1kΩ ±1% 1/8w	6250-2121
R510	RESISTOR, Film, 12.1kΩ ±1% 1/8w	6250-2121
R511	RESISTOR, Composition, 1kΩ ±5% 1/2w	6100-2105
R512	RESISTOR, Precision, 3.01kΩ ±1% 0.3w	6730-1301
R513	POTENTIOMETER, Wire-Wound, 330Ω ±5%	0971-4250
R514	RESISTOR, Precision, 180Ω ±1%	6690-6229
R515	RESISTOR, Precision, 180Ω ±1%	6690-6229
R516	RESISTOR, Precision, 180Ω ±1%	6690-6229
R517	RESISTOR, Precision, 180Ω ±1%	6690-6229
R518	RESISTOR, Precision, 180Ω ±1%	6690-6229
R519	RESISTOR, Precision, 180Ω ±1%	6690-6229
R520	RESISTOR, Precision, 180Ω ±1%	6690-6229
R521	RESISTOR, Precision, 180Ω ±1%	6690-6229
R522	RESISTOR, Precision, 180Ω ±1%	6690-6229
R523	RESISTOR, Precision, 180Ω ±1%	6690-6229
R524	RESISTOR, Precision, 180Ω ±1%	6690-6229
R525	RESISTOR, Precision, 3.01kΩ ±1% 0.3w	6730-1301
R526	RESISTOR, Film, 18.2kΩ ±1% 1/8w	6250-2182
R527	RESISTOR, Composition, 7.5kΩ ±5% 1w	6110-1515
R528	RESISTOR, Composition, 7.5kΩ ±5% 1/2w	6100-2755
R529	POTENTIOMETER, Composition, 5kΩ ±20%	6040-0600
C501A, C501B, C501C	CAPACITOR, Electrolytic, 450µf / 225µf / 225µf 100dcwv	4450-4000
C502A, C502B, C502C	CAPACITOR, Electrolytic, 450µf / 225µf / 225µf 100dcwv	4450-4000
C503	CAPACITOR, Electrolytic, 6.8µf ±20% 35v	4450-5000
C504	CAPACITOR, Electrolytic, 15µf ±20% 20v	4450-5200
C505	CAPACITOR, Ceramic, 0.01µf +80-20% 500dcwv	4406-3109
C506	CAPACITOR, Electrolytic, 6.8µf ±20% 35v	4450-5000
CR501	DIODE, Type 1N3253	6081-1001
CR502	DIODE, Type 1N3253	6081-1001
CR503	DIODE, Type 1N3253	6081-1001
CR504	DIODE, Type 1N3253	6081-1001
CR505	DIODE, Type 1N759A	6083-1014
CR506	DIODE, Type 1N759A	6083-1014
CR507	DIODE, Type 1N2166A	6083-1011
CR508	DIODE, Type 1N3681B	6083-1027
CR509	DIODE, Type 1N3681B	6083-1027
F501	FUSE, 115v, 0.125a	5330-0450
	230v, 0.062a	5330-0300
F502	FUSE, 115v, 0.125a	5330-0450
	230v, 0.062a	5330-0300
J501	JACK, Reference Voltage	4260-0500
PL501	PLUG, Power	4240-0600
Q501	TRANSISTOR, Type 2N696	8210-1033
Q502	TRANSISTOR, Type 2N696	8210-1033
Q503	TRANSISTOR, Type 2N2196	8210-1041
Q504	TRANSISTOR, Type 2N1131	8210-1025
Q505	TRANSISTOR, Type 2N190	8210-1037
Q506	TRANSISTOR, Type 2N190	8210-1037
Q507	TRANSISTOR, Type SA2022	8210-1046
Q508	TRANSISTOR, Type 2N1131	8210-1025
S501	SWITCH, Power	7910-1300
S502	SWITCH, Rotary Wafer	7890-3400
T501	TRANSFORMER	0345-4005

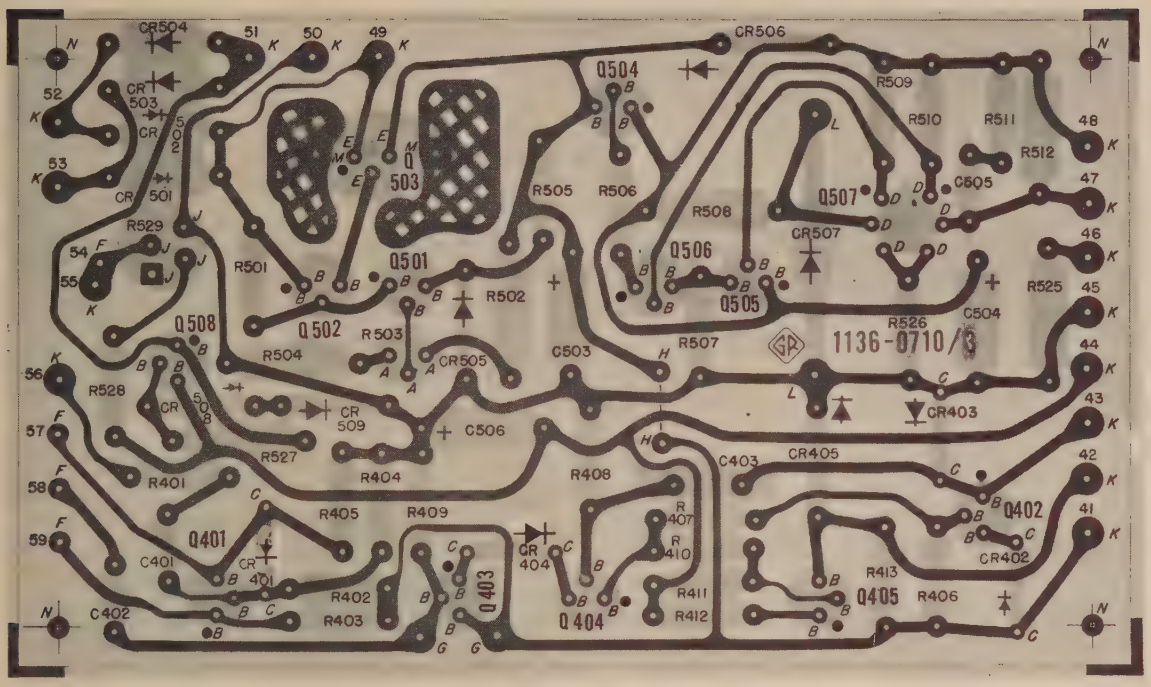
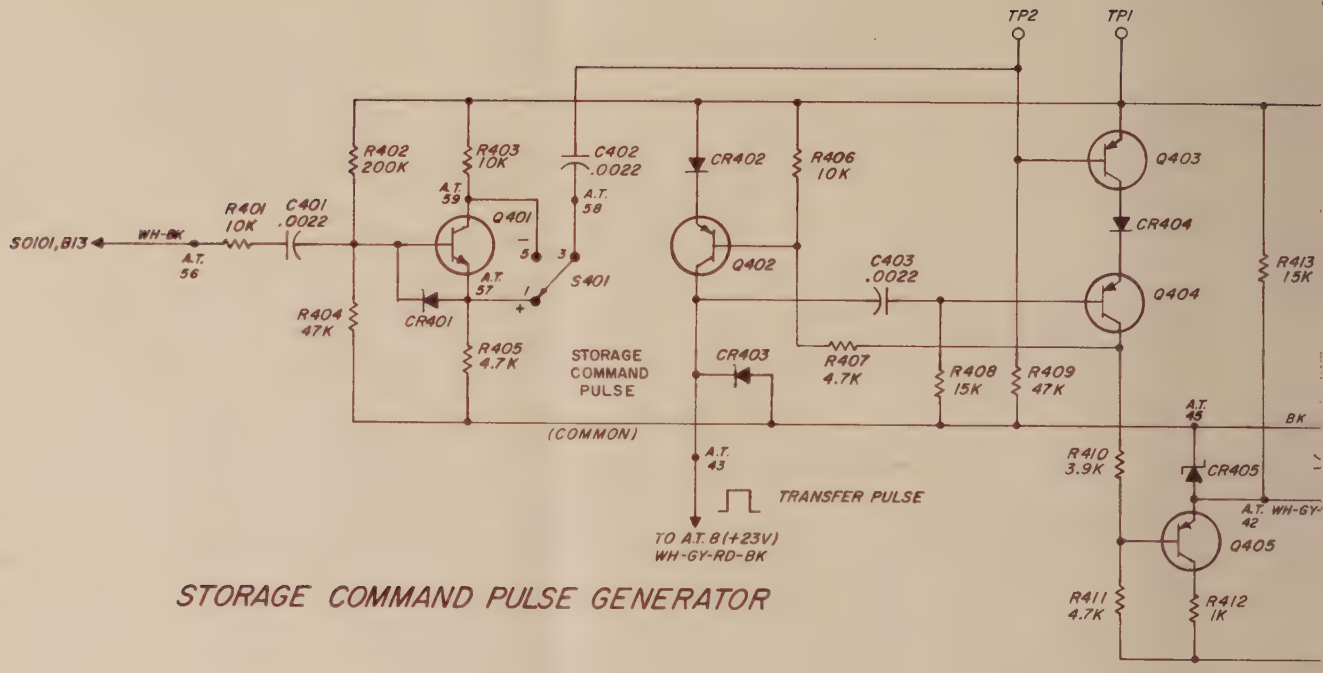


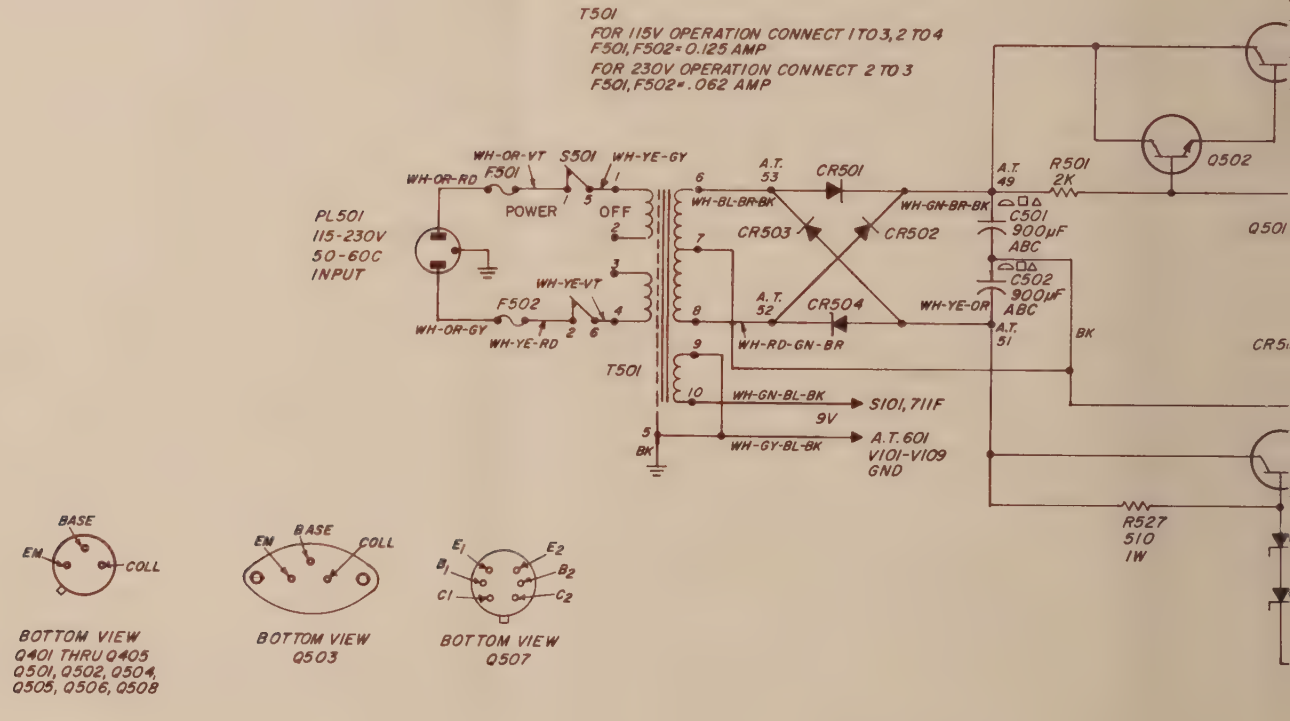
Figure 4-4. Etched-board layout for power supply.

PARTS LIST

REF NO.	DESCRIPTION	PART NO.
R401	RESISTOR, Composition, 10kΩ ±5% 1/2w	6100-3105
R402	RESISTOR, Composition, 200kΩ ±5% 1/2w	6100-4205
R403	RESISTOR, Composition, 10kΩ ±5% 1/2w	6100-3105
R404	RESISTOR, Composition, 47kΩ ±5% 1/2w	6100-3475
R405	RESISTOR, Composition, 4.7kΩ ±5% 1/2w	6100-2475
R406	RESISTOR, Composition, 10kΩ ±5% 1/2w	6100-3105
R407	RESISTOR, Composition, 4.7kΩ ±5% 1/2w	6100-2475
R408	RESISTOR, Composition, 15kΩ ±5% 1/2w	6100-3155
R409	RESISTOR, Composition, 47kΩ ±5% 1/2w	6100-3475
R410	RESISTOR, Composition, 3.9kΩ ±5% 1/2w	6100-2395
R411	RESISTOR, Composition, 4.7kΩ ±5% 1/2w	6100-2475
R412	RESISTOR, Composition, 1kΩ ±5% 1/2w	6100-2105
R413	RESISTOR, Composition, 15kΩ ±5% 1/2w	6100-3155
C401	CAPACITOR, Ceramic, 0.0022μf ±10% 500dcwv	4406-2228
C402	CAPACITOR, Ceramic, 0.0022μf ±10% 500dcwv	4406-2228
C403	CAPACITOR, Mica, 0.0022μf ±5% 300dcwv	4580-0500
CR401	DIODE, Type 1N645	6082-1016
CR402	DIODE, Type 1N645	6082-1016
CR403	DIODE, Type 1N645	6082-1016
CR404	DIODE, Type 1N3604	6082-1001
CR405	DIODE, Type 1N750A	6083-1028
Q401	TRANSISTOR, Type 2N910	8210-1037
Q402	TRANSISTOR, Type 2N1131	8210-1025
Q403	TRANSISTOR, Type 2N1303	8210-1019
Q404	TRANSISTOR, Type 2N1131	8210-1025
Q405	TRANSISTOR, Type 2N1303	8210-1019
S401	SWITCH	7910-0770



STORAGE COMMAND PULSE GENERATOR



BOTTOM VIEW Q401 THRU Q405 Q501, Q502, Q504, Q505, Q506, Q508

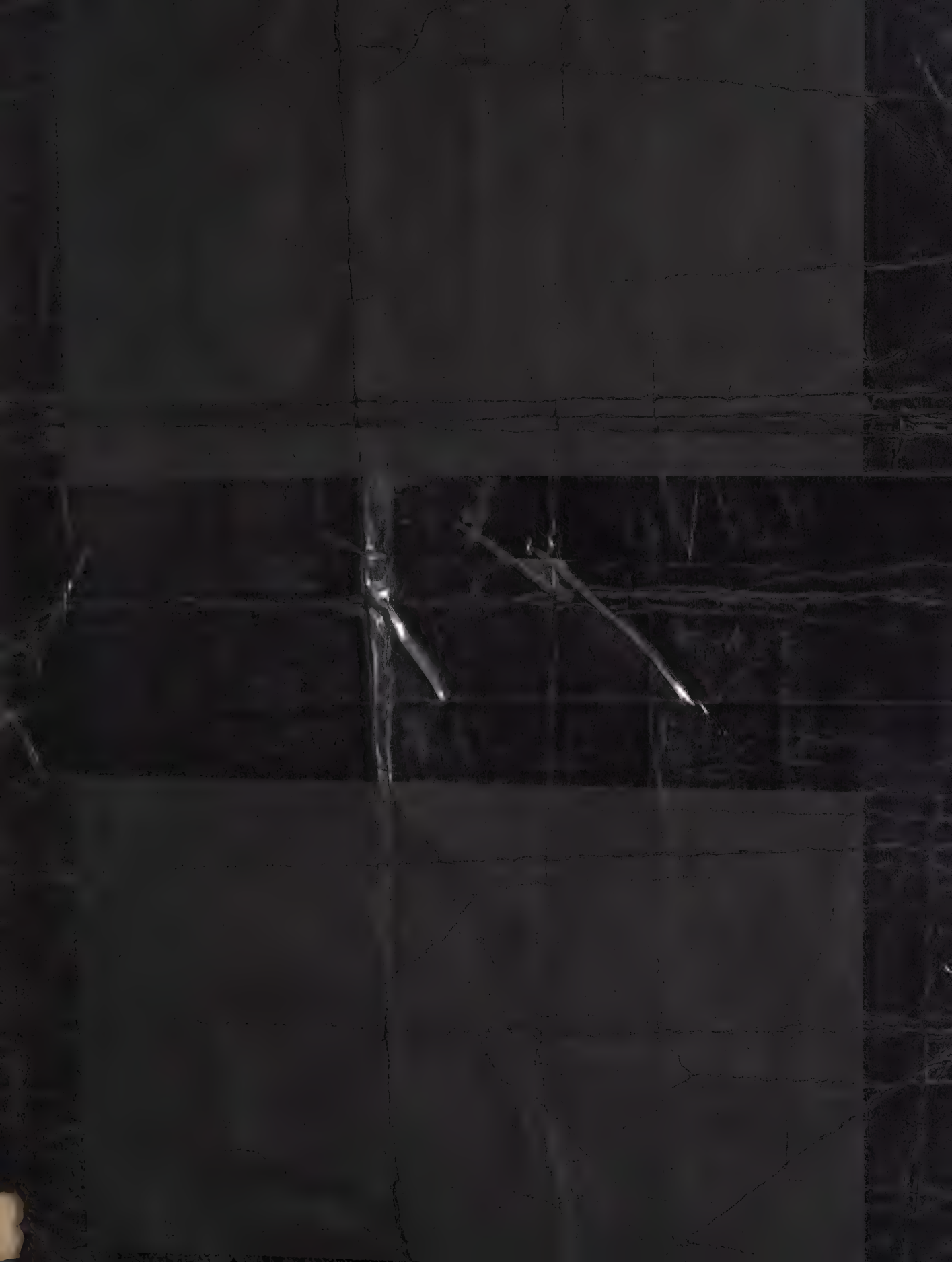
BOTTOM VIEW Q503

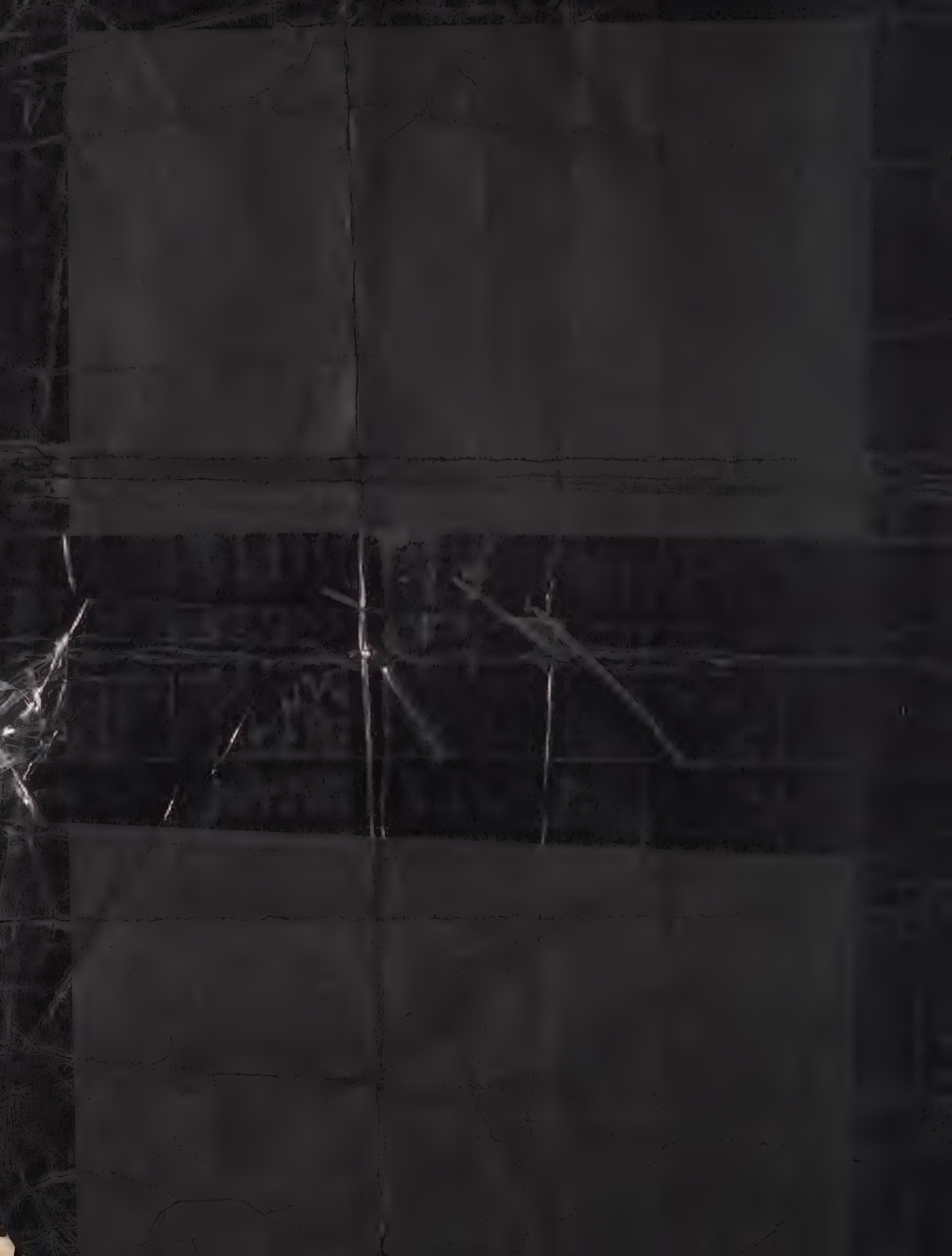
BOTTOM VIEW Q507

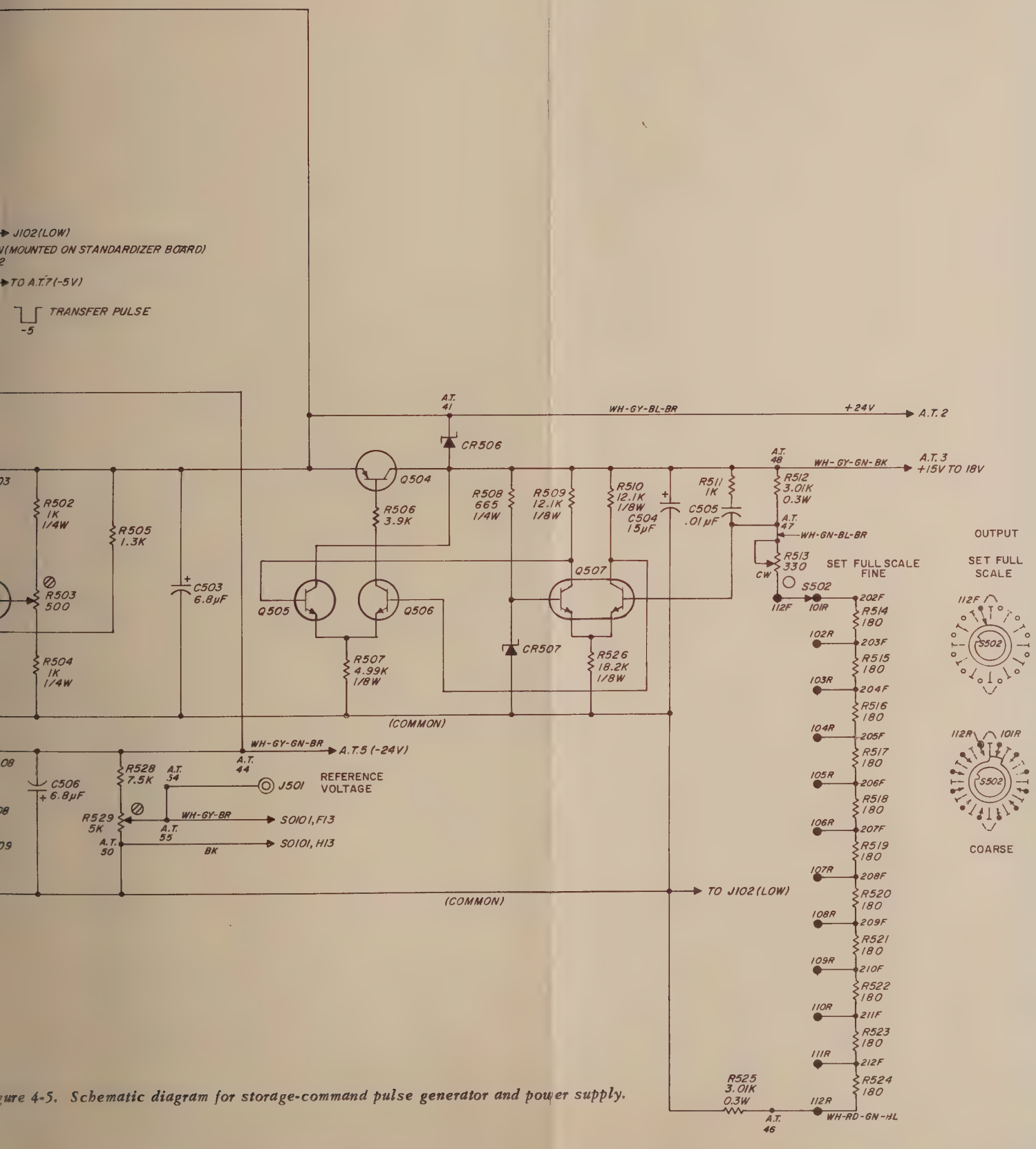
NOTE UNLESS SPECIFIED

1. ROSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.
4. RESISTORS 1/2 WATT.
5. RESISTANCE IN OHMS K = 1000 OHMS M = 1 MEGOHM
6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS.
7. ◯ KNOB CONTROL
8. ⊘ SCREWDRIVER CONTROL
9. AT - ANCHOR TERMINAL
10. TP - TEST POINT

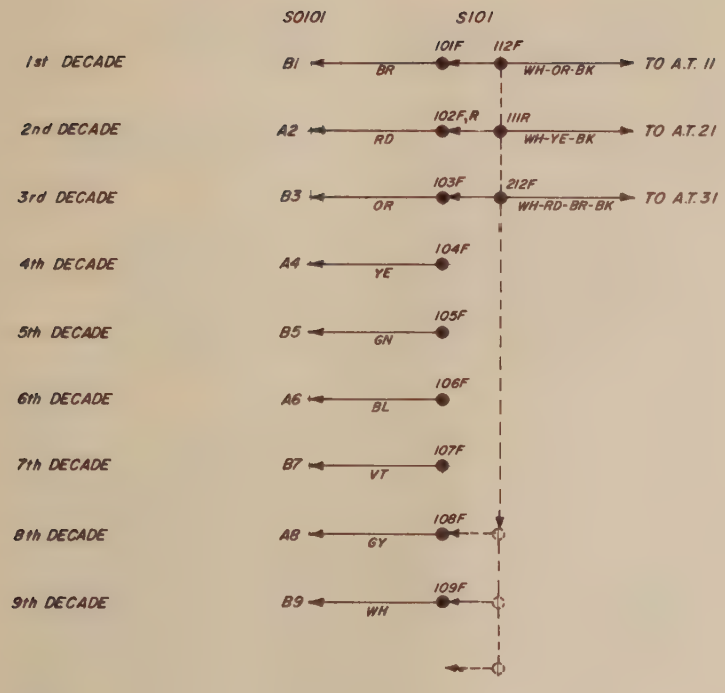
ANCHOR TERMINALS USED: A.T. 41 THRU 59
TEST POINTS USED: TP1 & TP2

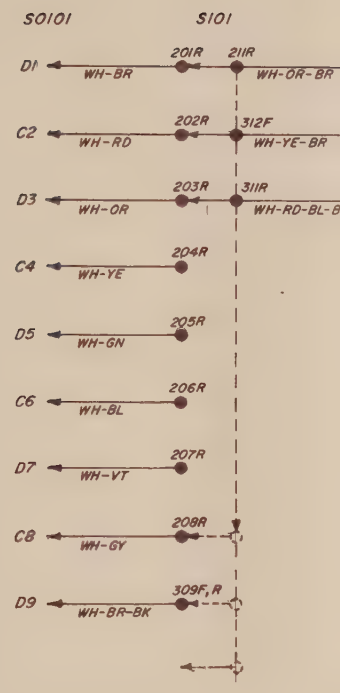




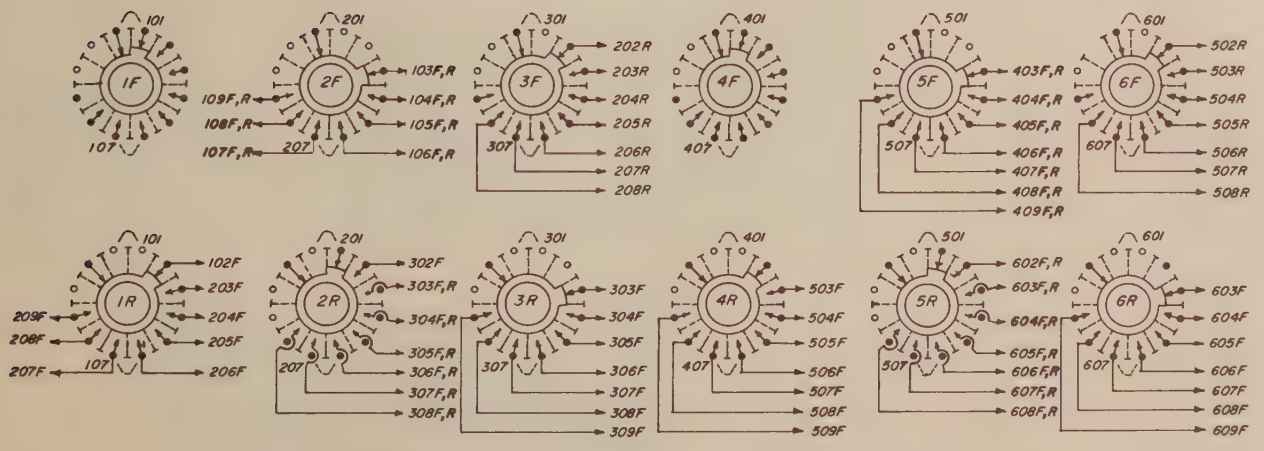


ure 4-5. Schematic diagram for storage-command pulse generator and power supply.





S101 SWITCH CONNECTIONS



S101 SWITCH WAFER DELINEATION & CONNECTIONS VIEWED FROM KNOB CONTROL

NOTE: FOR SWITCH CONTACTS WITHOUT DESIGNATIONS SEE FLIP-FLOP STAGES ABOVE

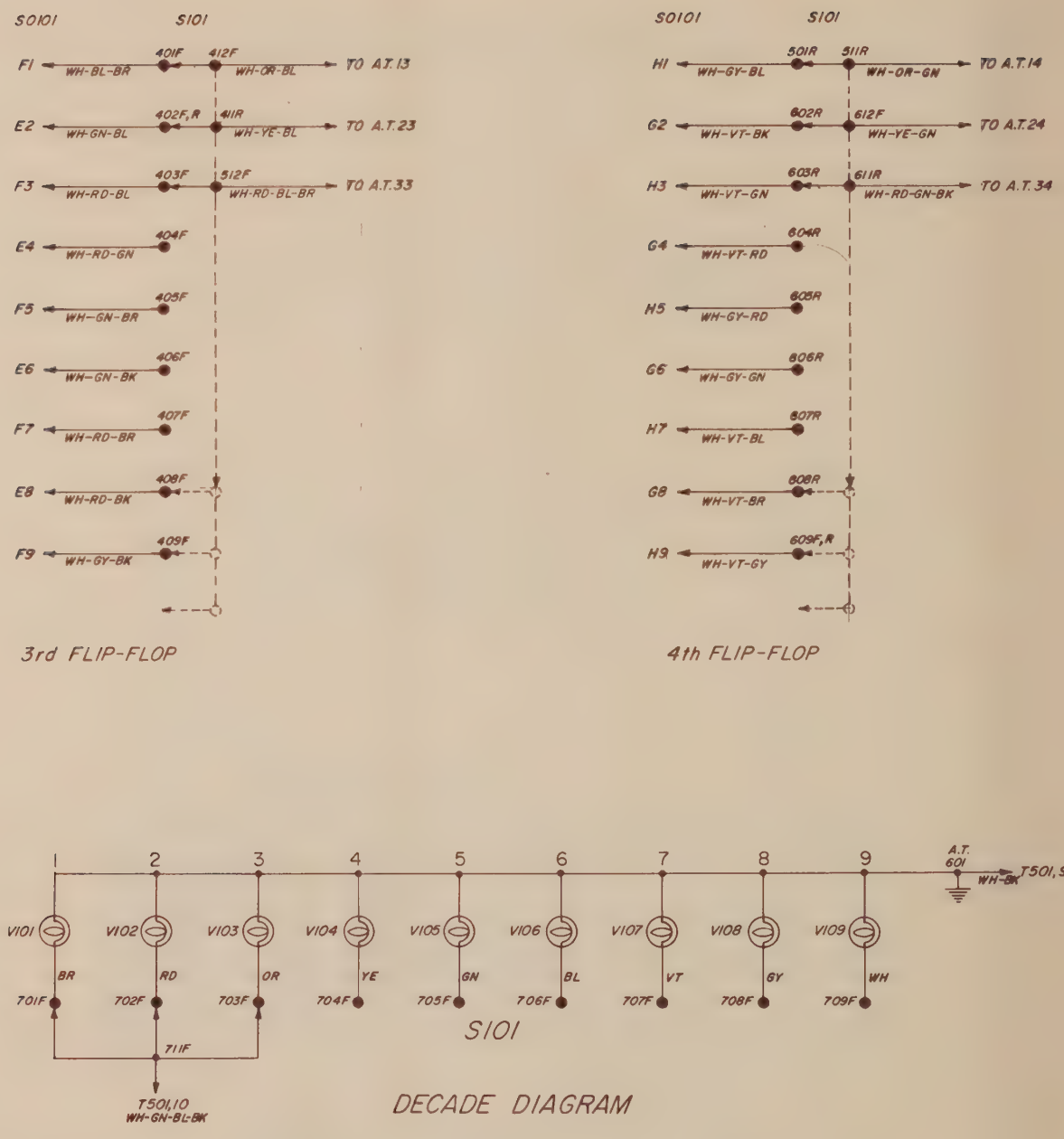
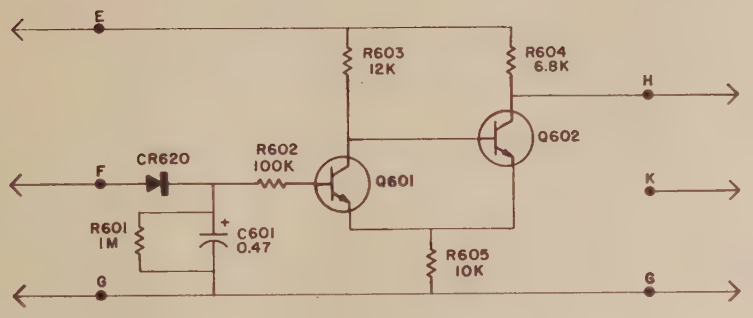
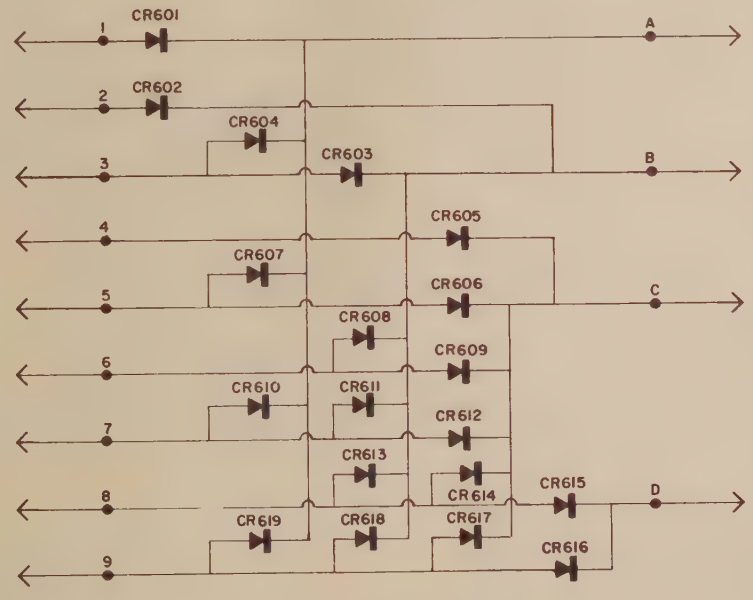


Figure 4-6. Switch connections for Type 1136-A.

COUNTER CONNECTOR (PL602) TERMINAL NO.	WIRE COLOR	ETCHED-BOARD TERMINAL NO.
GROUP 1 TO 1136-2720,BR		
G6	WH-BR	1
G8	WH-RD	2
G10	WH-OR	3
G12	WH-YE	4
H1	WH-GN	5
H3	WH-BL	6
H5	WH-VT	7
H7	WH-GY	8
H9	WH	9
GROUP 2 TO 1136-2721,RD		
E12	WH-BR	1
F1	WH-RD	2
F3	WH-OR	3
F5	WH-YE	4
F7	WH-GN	5
F9	WH-BL	6
F11	WH-VT	7
F13	WH-GY	8
G2	WH	9
GROUP 3 TO 1136-2722,OR		
D5	WH-BR	1
D7	WH-RD	2
D9	WH-OR	3
D11	WH-YE	4
D13	WH-GN	5
E2	WH-BL	6
E4	WH-VT	7
E6	WH-GY	8
E8	WH	9
GROUP 4 TO 1136-2723,YE		
B11	WH-BR	1
B13	WH-RD	2
C2	WH-OR	3
C4	WH-YE	4
C6	WH-GN	5
C8	WH-BL	6
C10	WH-VT	7
C12	WH-GY	8
D1	WH	9
GROUP 5 TO 1136-2724,GN		
A4	WH-BR	1
A6	WH-RD	2
A8	WH-OR	3
A10	WH-YE	4
A12	WH-GN	5
B1	WH-BL	6
B3	WH-VT	7
B5	WH-GY	8
B7	WH	9
GROUP 6 TO 1136-2730		
H13	WH-BK	F
CLAMP	BK	G
H11	RD	E



GROUP 6



GROUPS 1 THROUGH 5

CONVERTER CONNECTOR (PL601) TERMINAL NO.	WIRE COLOR	ETCHED-BOARD TERMINAL NO.
GROUP 1 TO 1136-2720,BR		
B1	BR	A
D1	WH-BR	B
F1	WH-BL-BR	C
H1	WH-GY-BL	D
GROUP 2 TO 1136-2721,RD		
A2	RD	A
C2	WH-RD	B
E2	WH-GN-BL	C
G2	WH-VT-BR	D
GROUP 3 TO 1136-2722,OR		
B3	OR	A
D3	WH-OR	B
F3	WH-RD-BL	C
H3	WH-VT-GN	D
GROUP 4 TO 1136-2723,YE		
A4	YE	A
C4	WH-YE	B
E4	WH-RD-GN	C
G4	WH-VT-RD	D
GROUP 5 TO 1136-2724,GN		
B5	GN	A
D5	WH-GN	B
F5	WH-GN-BR	C
H5	WH-GY-RD	D
GROUP 6 TO 1136-2730		
B13	WH-BK	H
H13	BK	G
D13	WH-BL-BK	K
F13	WH-GY-BR	K

NOTE UNLESS SPECIFIED

1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE.
2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK.
3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM.
4. RESISTORS 1/4 WATT.
5. RESISTANCE IN OHMS K 1000 OHMS M 1 MEGOHM
6. CAPACITANCE VALUES ONE AND OVER IN PICOFARADS. LESS THAN ONE IN MICROFARADS.
7. ◯ KNOB CONTROL
8. ⊘ SCREWDRIVER CONTROL
9. AT ANCHOR TERMINAL
10. TP TEST POINT

Figure A-3. Schematic diagrams for the decimal-BCD matrix of the Type 1136-P1 Cable.

Type 1151-A DIGITAL TIME AND FREQUENCY METER

Frequency Measurement:
Range — DC to 300 kc.
Sensitivity — 0.1 volt, peak-to-peak, at 100 kilohms or 1 volt, peak-to-peak, at 1 megohm (1 microampere), switch-selected.
Counting Interval — 10 milliseconds to 10 seconds, extendible by multiplier switch.
Accuracy — ±1 count ± crystal-oscillator stability.
Period Measurement:
Range — DC to 20 kc.
Number of Periods — 1, 10, 100, or 1000.
Sensitivity — 0.1 volt at 100 kilohms or 1 volt, peak-to-peak, at 1 megohm (1 microampere), switch-selected.
Accuracy — ±1 count ± time base accuracy ± noise errors.
Input Noise — 5 millivolts equivalent open-circuit input noise.
Counted Frequency — 100 kc.
Ratio Measurement:
Range — B/A, 10 B/A, 100 B/A, or 1000 B/A.
Frequency Range — A input, dc to 20 kc; B input, dc to 300 kc.
B Input — 1 volt peak-to-peak, 100 kilohms.
Display: 5-digit, in-line Numerik register, incandescent-lamp operated.
Display Time: 0.16, 0.32, 0.64, 1.28, 2.56, 5.12, or 10.24 seconds, switch selected.
Input Impedance: 1 megohm shunted by 50 pf or 100 kilohms shunted by 500 pf, switch-selected.
Input Trigger Level: ±1 volt at 0.1-volt sensitivity; ±10 volts at 1-volt sensitivity.
Input Trigger Slope: AC or dc coupled, positive- or negative-going.
Crystal-Oscillator Stability:
Short-Term — Better than ½ part per million.
Cycling — Less than counter resolution.
Temperature Effects — Less than 2½ parts per million for rise of 0 to 50 C ambient.
Warmup — Within 1 part per million after 15 minutes.
Aging — Less than 1 part per million per week after four weeks, decreasing thereafter.
Crystal Frequency Accuracy: The frequency is within 10 parts per million when shipped. Frequency adjustment is provided.
Power Requirements: 105 to 125 (or 210 to 250) volts, 50 to 60 cps, 50 watts.
Accessories Supplied: TYPE CAP-22 Power Cord, eight replacement incandescent lamps, spare fuses.
Cabinet: Rack-bench.
Dimensions: Bench model — width 19, height 3⅞, depth 12½ inches (485 by 99 by 320 mm), over-all; rack model — panel 19 by 3½ inches (485 by 90 mm), depth behind panel 12¾ inches (325 mm).
Net Weight: 19 pounds (9 kg). **Shipping Weight:** 22 pounds (10 kg)

Type		*Code Number*
1151-APM	**Digital Time and Frequency Meter** (with output for printer or D/A converter), Bench Model	1151-9871
1151-APR	**Digital Time and Frequency Meter** (with output for printer or D/A converter), Rack Model	1151-9981

Type 1521-A GRAPHIC LEVEL RECORDER

Dynamic Range: With potentiometer furnished, 0 to 40 db for level recording (20-db and 80-db potentiometers are also available); 0 to 0.8 volt (at 1000 ohms) full scale, for dc recording with zero input position adjustable over full scale.
Frequency Response
Level Recorder: 20 cps to 200 kc (within 3 db).
DC Recorder: 0 to 10 cps (peak-to-peak amplitude less than 25% of full scale).
Potentiometer Linearity
Level Recorder: ±1% of full-scale db value plus a frequency error of 0.5 db at 100 kc and 1.5 db at 200 kc.
DC Recorder: ±1% of full scale.
Resolution: ±0.25% of full scale.
Maximum Input Voltage: 100 volts, ac.
Input Attenuator: 60 db in 10-db steps.
Input Impedance: 10,000 ohms for ac level recorder; 1000 ohms for dc recorder.
Maximum Sensitivity: 1 millivolt at 0 db for level recording; 0.8 volt full scale for dc recording.
General
Paper Speeds: 2.5 inches per minute to 75 inches per minute. A slow-speed motor to provide speeds of 2.5 to 75 inches per hour is available as an alternate. See below.
Writing Speed: 1, 3, 10, or 20 inches per second (approximately), with overshoot less than 1 db.
Oscillator or Analyzer Drive: Order TYPE 1521-P10B Drive Unit and appropriate link unit.
External DC Reference: Internal terminals are provided for an external dc voltage, which can be substituted for the 1-volt internal dc reference. The recorder will operate properly over a 3:1 reference-voltage range (0.5 to 1.5 volts). If this reference voltage is derived from the source of energy in the system under test, variations of up to 3:1 in the source output can be eliminated from the recording.
Detector: Quasi-rms; within 0.25 db of rms for multiple sine waves, square waves, or noise. Detector operating level is 1 volt.
Chart Paper: 4-inch recording width on 5-inch paper. Charts have 8 major divisions, 40 total divisions on vertical scale, except 1521-9427, which has 80 total divisions, and 1521-9466, which has 50.
Accessories Supplied: 40-db potentiometer, 2 pens, 2-ounce bottle of red ink, 2-ounce bottle of green ink, bottle of potentiometer cleaner, 1 roll of 1521-9428 paper, droppers for filling pens, CAP-22 Power Cord, spare fuses, adaptor cable for connection to sound-measuring equipment and other devices having telephone jacks.
Accessories Available: Potentiometers, charts, ink, slow-speed motors, drive and link units, as listed in price table.
Power Requirements: 105 to 125 (or 210 to 250) volts, 60 cps, 35 watts. 50-cycle models are available; see price list below.
Cabinet: Rack-bench.
Dimensions: Bench model — width 19, height 9, depth 13½ inches (485 by 230 by 350 mm), over-all; rack model — panel 19 by 8¾ inches (485 by 225 mm), depth behind panel 11¼ inches (290 mm).
Net Weight: 50 pounds (23 kg).
Shipping Weight: 64 pounds (29 kg).

Type	*Mounting*	*Supply Frequency*	*Paper Speed*	*Code Number*
1521-AR	Rack	60 cps	2.5-75 in./min	1521-9811
1521-AM	Bench	60 cps	2.5-75 in./min	1521-9801
1521-ARQ1	Rack	50 cps	2.5-75 in./min	1521-9496
1521-AMQ1	Bench	50 cps	2.5-75 in./min	1521-9495

Range	CAPACITANCE IKC Min.	Max		CONDUCTANCE IKC Min	Max
1	000.01 0.01 pf	150.00 150 pf	pf	0.1	1500.0
2	0150.0 150 pf	1500.0 1500 pf	pf	1.500	15.000
3	1.500 1500 pf	15.000 15,000 pf	nf	15.00	150.00
4	15.00 15,000 pf	150.00 150,000 pf	nf	150.0	1500.0
5	150.0 150,000 pf	1500.0 1500,000 pf	nf	[illegible]	[illegible]
6	1.500	15.000	uf	[illegible]	[illegible]
7	15.00	150.00	uf	[illegible]	[illegible]

[illegible]

1K Ω = 1 x 10^{-3} Ω = 1 mΩ = 1000 μΩ = Range 4

10K Ω = [illegible]

100K Ω = [illegible]

1 MEG Ω = 1 x 10^{-6} Ω = 1 μΩ = 1000 nΩ = Range 1

SHORT = Range 7

OPEN = Range 1

[illegible]

Photo courtesy of Electronics Products Division of Corning Glass Works.

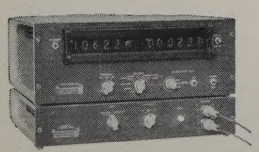
Customer Report:

1680-A Eliminates Human Error

Corning Glass Works' Electronics Products Division uses a GR automatic capacitance-measuring and recording system in its Quality Control Laboratory to log data of capacitors under test in an environmental chamber. The brains of the system is a GR 1680-A Automatic Capacitance Bridge Assembly, which is used with an automatic component indexer and an IBM 526 Card Punch. Each capacitor is placed across the bridge's input terminals by the indexer; almost instantly the measured values are automatically punched on an IBM card. Human error is thus eliminated, and data acquisition is made rapidly, accurately, efficiently, and in a form suitable for computer processing.

The 1680-A automatically selects C and D (or G) ranges, balances, and displays measurements in digital form, showing decimal point and units of measurement. Measurement takes only 0.5 second at 1 kHz under worst conditions. Basic accuracy is 0.1% of reading for C and G, 1% of reading ±0.001 for D. Measurement range is 0.01 pF to 1000 μF.

For complete information, write General Radio Company, 22 Baker Avenue, W. Concord, Massachusetts 01781; telephone: (617) 369-4400; TWX: 710 347-1051.



Type 1680-A Automatic Capacitance Bridge Assembly, $4975 in U.S.A.

GENERAL RADIO

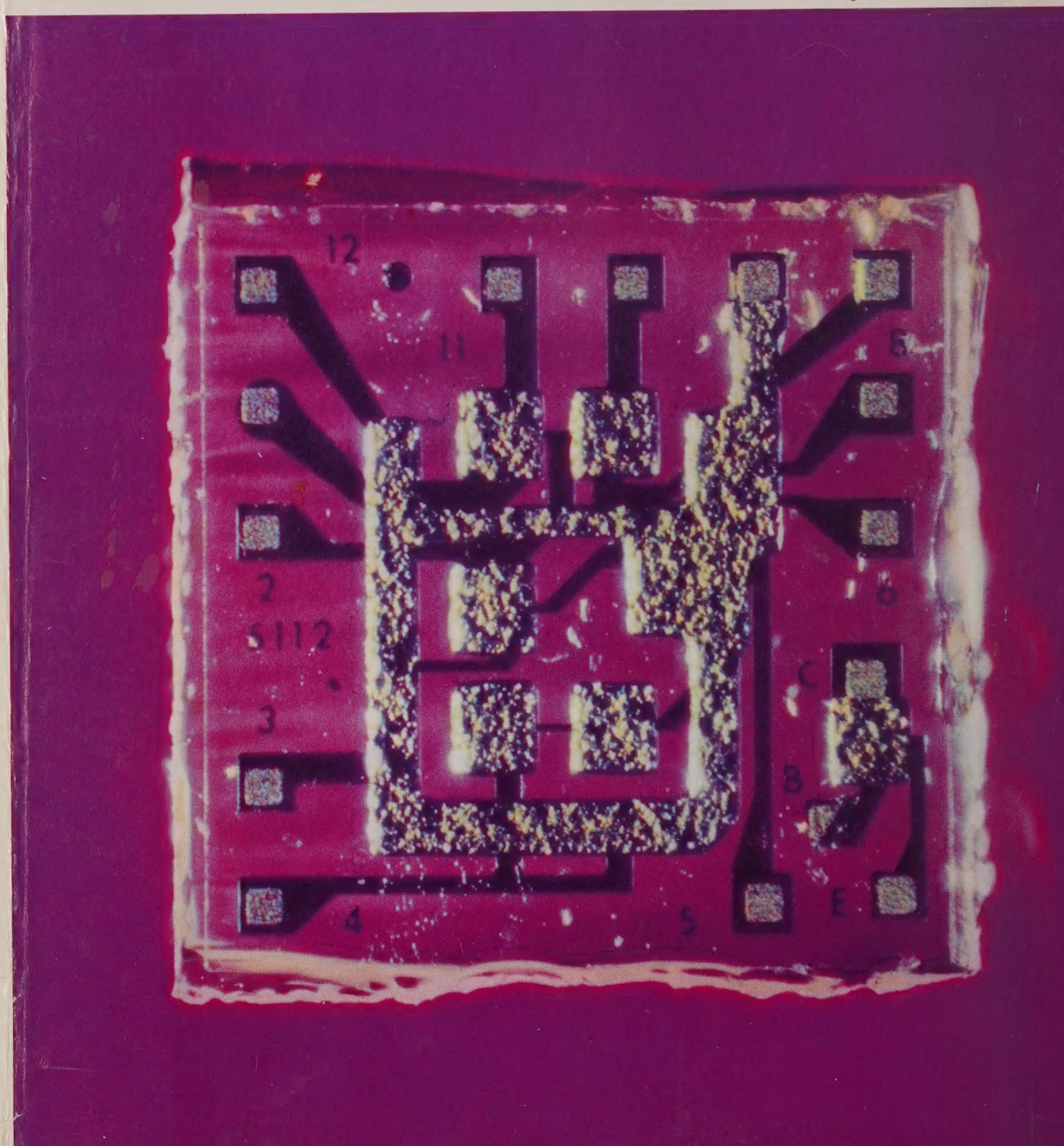
Circle 900 on reader service card

Electronics®

Detecting signals digitally: page 82
Integrated techniques for microwave: page 112
Computers that fit on space projects: page 127

March 20, 1967
$1.00
A McGraw-Hill Publication

Below: Glass isolates integrated circuits, page 91



Electronics

Special feature: Dielectric isolation

March 20, 1967

RECORDER ACCESSORIES

CHART PAPER — 100-FOOT ROLLS

Type		*Code Number*
1521-9466	**Linear time base, 1 division = 5/8 inch; 10 major divisions, 50 total divisions. For use with Types 1134-A and 1136-A Digital-to-Analog Converters.**	1521-9466

INK

1521-4092	**16-ounce bottle of red ink**	1521-4092
1521-4093	**16-ounce bottle of green ink (for ozalid copies)**	1521-4093

POTENTIOMETERS

Type		*Code Number*
1521-P1	**20 db**	1521-9601
1521-P2*	**40 db**	1521-9602
1521-P3	**80 db**	1521-9603
1521-P4**	**Linear (for dc)**	1521-9604

* Supplied with recorder.

** Order Type 1521-P4 for use with Type 1136-A Digital-to-Analog Converter.

MOTORS FOR LOWER CHART SPEED††

1521-P20	**(60 cps) for paper speeds of 2.5-75 inches/hour**	1521-9620
1521-P22	**(50 cps) for paper speeds of 2.5-75 inches/hour**	1521-9622

†† Recorder can be supplied with low-speed motor installed.

GENERAL RADIO COMPANY

WEST CONCORD, MASSACHUSETTS*

EMerson 9-4400 Mission 6-7400

SALES ENGINEERING OFFICES

METROPOLITAN NEW YORK*

Broad Avenue at Linden
Ridgefield, New Jersey
Telephone N.Y. WOrth 4-2722
N.J. WHitney 3-3140

SYRACUSE

Pickard Building
East Molloy Road
Syracuse 11, New York
Telephone GLenview 4-9323

PHILADELPHIA

1150 York Road
Abington, Pennsylvania
Telephone TUrner 7-8486
Phila., HAncock 4-7419

WASHINGTON* and BALTIMORE

Rockville Pike at Wall Lane
Rockville, Maryland
Telephone 946-1600

ORLANDO

113 East Colonial Drive
Orlando, Florida
Telephone GArden 5-4671

CHICAGO*

6605 West North Avenue
Oak Park, Illinois
Telephone VIllage 8-9400

CLEVELAND

5579 Pearl Road
Cleveland 29, Ohio
Telephone 886-0150

LOS ANGELES*

1000 North Seward Street
Los Angeles 38, California
Telephone HOllywood 9-6201

SAN FRANCISCO

1186 Los Altos Avenue
Los Altos, California
Telephone WHitecliff 8-8233

DALLAS

2501-A West Mockingbird Lane
Dallas 35, Texas
Telephone FLeetwood 7-4031

TORONTO*

99 Floral Parkway
Toronto 15, Ontario, Canada
Telephone CHerry 7-2171

MONTREAL BRANCH

Office 395 1255 Laird Boulevard
Town of Mount Royal, Quebec, Canada
Telephone 737-3673

* Repair services are available at these offices.

General Radio Company (Overseas), Zurich, Switzerland
Representatives in Principal Overseas Countries

Printed in USA